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TEACHER ORGANIZATIONS

Conditions surrounding the teaching profession have never encouraged prodigal spending, but the past four years have forced teachers to extreme frugality. Even those things necessary for spiritual comfort and intellectual development have been eliminated along with ordinary physical needs. But the barometer indicates improving conditions. Salary cuts are no longer applauded by taxpayers; in a few cases increases are reported. It is time for teachers to seek means for restoring those discontinued activities necessary for maintaining professional growth and for preventing intellectual stagnation. Chief among these is support of professional and community organizations. The following extracts from *The Bulletin* of the Milwaukee Teachers' Association are worthy of attention:

Organizations are a vital part of American life. They play a tremendous part in forming public opinion and in securing concerted action. The welfare of the public schools is inextricably interwoven with the activities of community groups. The teacher who takes part in community organizations with most benefit to the schools, is one who can readily translate the definite knowledge of the educational specialist into ordinary language that the lay citizen can easily understand. Through participation in them, he builds up an enlightened public opinion which is essential to achieving the purposes of education.

Teachers have splendid national, state and local organizations devoted to the advancement of professional standards and to the maintenance of good schools throughout the nation. These organizations constitute a powerful force in American life. Teachers' associations exert an important influence over public opinion and are heard by those who occupy positions of responsibility.

The effectiveness of a teachers' organization is determined largely by two factors:

1. The proportion of teachers eligible to membership who give it their allegiance and support.

2. The degree of skill displayed by the leaders of the group in creating public opinion favorable to the measures proposed. The importance of 100 per cent membership is clear; every teacher who fails to contribute his proportionate share of time, money and energy to the work of an organization thereby destroys part of its potential influence. Skillful publicity is vital to success, because teachers' associations use persuasion rather than compulsion to gain their objectives.

SCIENCE MURAL

By Robert L. Black, *Emmerick Manual Training High School, Indianapolis*

For several years, I have felt very keenly the need of illustration material in my work as a high school teacher of science. I have been especially anxious to interest my students in the history of science.

I am fortunate in having an artist in the family, Elmer E. Taflinger, and I succeeded in enlisting his enthusiasm and ability in my project. Together we planned a painting which would portray the development of science in mural form. We selected the names of twenty outstanding scientists of all ages and submitted the list to one hundred and seven representative scientists, educators and editors for their approval or suggestions.

By analyzing the eighty-three replies received, we eliminated three of the twenty scientists in the list, and we added the names of thirty-five others, bringing the total number of scientists represented in the mural to fifty-two.

The mural, about twenty feet long and five feet high, is to be in three panels. The center panel represents the development of biology, and the panels on each side of the center represent the development of the "big ideas" in each of the sciences as portrayed by the representative scientists in that particular field.

The mural is progressing as fast as careful draftsmanship permits, and we hope to have the completed mural on exhibition at the time of the annual convention in Indianapolis on November 29–30.

AMENDMENTS TO THE BY-LAWS OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

At the next regular meeting of the Association, the following Amendments to the By-Laws will be presented.

Part III, Section 1. *Officers.* The officers of this association shall be a President, a Vice-President, a Secretary-Treasurer. One or more Assistant Secretaries and Assistant Treasurers may be appointed by the President.

Part III, Section 4. *Powers and Duties of Officers.*

(c) Secretary-Treasurer: The Secretary-Treasurer shall keep all records. He shall record the minutes of all meetings. He shall carry on correspondence of the Association under the direction of the Executive Committee. He shall collect membership dues. He shall give a detailed report at each meeting of his receipts and disbursements. He shall pay out funds on the order of the Board of Directors and the Executive Committee.

Central Association

of

Science and Mathematics Teachers

Incorporated

1933-1934

Program

34th Annual Convention

Hotel Lincoln

Indianapolis, Indiana

THE ANNUAL CONVENTION of *Central Association of Science and Mathematics Teachers* is to be held in Indianapolis at the Lincoln Hotel, November 30 and December 1, 1934. The local arrangements committee with Walter G. Gingery as chairman is busy in an effort to make this the best convention ever held by the Association. *Hearty Hoosier Hospitality* is the slogan.

Educators have long realized the value of this Association in furthering the cause of science and mathematics teaching and teachers. For over thirty years excellent programs have been given and the official journal, SCHOOL SCIENCE AND MATHEMATICS, has enjoyed an enviable circulation.

General programs are held on Friday and Saturday mornings. Section programs (Biology, Chemistry, Elementary Science, General Science, Geography, Mathematics, Physics) occur Friday afternoon from 1:30-3:30 P.M. There is a dinner program Friday evening.

We invite you to become a member of our Association. Plan now to attend the convention. Turn to page 880 for a pre-view of the program.

AN ANALYSIS OF THE TYPES OF SCIENTIFIC METHOD USED BY THE LAYMAN IN TYPICAL OUT-OF-SCHOOL SITUATIONS*

By Ralph K. Watkins
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In secondary education, we have come to a general acceptance of the thesis that many of the courses offered under the heading of general education should be organized to meet the needs of the layman. This may be said in another fashion, the organization of courses for general education as courses for consumers. This latter is sound phraseology if we broaden the term consumer to include various kinds of utilization as well as those uses based upon expenditures of money.

In science teaching, one of the aims consistently and persistently repeated by all those concerned has been the objective concerned with training in scientific method. Very little has been done by the teachers of science in an attempt at a rigorous definition of what is really included in the term, scientific method, as a training objective. The typical attitude has been, "Scientific method, why of course, everyone knows what is meant by scientific method."

In practice, scientific method has meant "experimental method." More specifically it has meant experiment under laboratory conditions. Actually in school situations the experimenting has degenerated into the attempt to solve set problems, almost invariably working toward known conclusions concerning long established facts and principles. The results of such a system of training have been anything except productive. Pupils after having undergone such training seem not to be able to apply scientific methods to problems which arise in their daily lives.

Attempts to measure the product under school conditions do not increase respect for the system of training in vogue. Horton's experiment[1] indicates that pupils in school laboratories

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* An address before a joint session of the Departments of Secondary Education and Science Instruction of the N.E.A. at Washington, D. C., July 1934.

[1] Horton, Ralph E. "Measurable Outcomes of Individual Laboratory Work in High School Chemistry." N.Y. Teachers College Contributions to Education No. 303, 1928.

learn certain simple manipulations of apparatus. Please note that this is not scientific problem solving. Also note that often these manipulations are strictly laboratory manipulations and may not be applicable in home, field, or office. Webb's[2] and Webb's and Beauchamp's[3] attempts at measurement of laboratory resourcefulness in problem solving do not show increased resourcefulness with increased laboratory training.

Common uncontrolled observation of individuals with high school and college laboratory training do not present a brighter side to the picture. These people continue to have homely superstitions, believe in luck, buy advertised nostrums, cosmetics, et al., believe the tobacco advertising, and patronize both quacks and fortune tellers.

As a result of lack of training in scientific methods of attack upon homely problems, the typical layman with school training accepts his science as a smattering of interesting facts, and believes the claims of the most blatant advertiser without investigation. As a matter of fact, it is probable that the individual with a smattering of factual knowledge of natural science facts may fall an easier dupe to some of the modern phases of charlatanism than an individual less sure of his own information. Claims based upon the supposed work of scientists; half truths; laboratory atmosphere; big words; chemical and medical terms; all these catch readily the individual who has "had science" but not learned to attack problems for himself.

It is time to take stock of the claims to training in scientific method from the point of view of the needs of the consumer of science. In order to make a beginning upon this problem, it was proposed to a small group of graduate students during the summer of 1933 that they attempt to discover the kinds of science problems common to the layman and to analyze the possible methods available to him for the solution of such problems.

No attempt was made at an exhaustive collection of the natural science problems of laymen. The kinds of problems and the methods used in their solution were in the focus of the attack. Each individual in the small seminar group, including the instructor, brought in problems from his own experience and those which could be picked up by observation of, and conversa-

[2] Webb, H. A. "Testing Laboratory Resourcefulness." School Science and Mathematics. March 1922, Vol. 22, pp. 259–267.

[3] Webb, H. A. and Beauchamp, R. O. "Resourcefulness an Unmeasured Ability." School Science and Mathematics. May 1927, Vol. 27, pp. 457–465.

tion with others. Only out-of-school problems actually occurring to non-specialists were considered.

The problems found were classified under the following general headings:

1. Control of the growth and well being of biological organisms (including human beings)
2. Destruction of undesirable biological organisms without injury to other more desirable ones
3. Determination of the relative values and usefulness of various mechanical devices, including small gadgets
4. Determination of values and uses of chemicals in fairly common use
5. Determination of the truth or falsity of advertising claims
6. Determination of the truth or falsity of statements from popular science sources
7. Settlement of conflicts between superstition, quackery, tradition and custom and proposed scientific solutions to problems
8. Determination of the relative costs of commodities which depend upon natural science factors for value

There are obvious overlappings in this classification. These overlappings have no great significance for our purposes here.

A few illustrative cases may serve to make the classification clearer. The first type of problems would include most of the problems having to do with the physical well being of an individual. Here would come problems of foods for both adults and children. Here also are to be found problems dealing with farm animals, pets, the growth of plants, gardening, and many wild life problems. For example, a neighbor has a rose garden. An authority says, "Do not sprinkle roses in watering." The weather is hot and dry. The leaves on the rose bushes are dusty. What shall be done? Why does the authority advise not to sprinkle?

Type two includes such problems as those having to do with clothes moth eradication; control of moles in gardens; fly and mosquito control; cabbage worms in the garden; etc.

Under the third grouping come such problems as determining the relative merits of mechanical and iced refrigerators; the value of individual springing on the front wheels of automobiles; supposed improvements in treads on automobile tires; and an endless number of similar problems involving mechanical devices.

In group four are found problems dealing with soaps, dentrifices, household antiseptics, cleaning agents, deodorants, and the like. A large part of the bulk of the advertising in household magazines is made up of claims for chemical agents of this kind.

Group five deals specifically with problems arising out of claims made in advertising. For example, is there any particular dietary value in "slow baked bread"? Or will such bread reduce weight as compared to the fattening qualities of other bread?

An illustration of the need for the verification of statements from popular science literature is to be found in the recent newspaper reports that an Italian scientist has artifically produced the 93rd element, and that this element has never existed on the earth before.

A problem growing out of a conflict between colloquial belief and a proposed scientific solution is the following. A barefoot boy steps on a rusty nail. The physician recommends anti-tetanus serum. Grandmother suggests smoking the wound in smoke from a burning woolen rag.

Illustrations for the last class may be found in the questions of economy growing out of the popularity of mechanical refrigeration. Does the mechanical refrigerator cost more or less to operate than the buying of ice? How much does it cost to operate a mechanical refrigerator? Is the advertiser's claim that his refrigerator costs no more to operate than an ordinary electric lamp true? Does a mechanical refrigerator enable the housewife to save on food bills?

In attempting to apply a scientific method of solution to these problems which could be operated by the layman without access to the elaborate paraphernalia of the laboratory, it became immediately obvious that different methods of problem solving must be applied to the various problems. If the thought processes which can be carried out by the layman are to be included in the term scientific method the term must become plural.

What are the useful methods of scientific attack upon homely problems? First, in many cases the layman must learn to analyze the problem into its very specific and pertinent parts in order to determine exactly wherein the crux of the matter lies. For example, given a very attractive sales talk for a mechanical gadget, it would be very helpful to raise questions such as these. Do I need such a gadget at all? What difference in operation shall I make if I continue to do without? Will the gadget work at all? What scientific principle is involved in its operation? How often will I use the thing? What will it cost? What is the purchase price? What is the cost of doing without? What is the cost of another device for doing the same thing? What service and replacement costs are involved? What is the normal

cost of operation? What damages to life and property might result from the use of the gadget? How long will it last?

In many of the problems presenting themselves to the average citizen, an experimental attack involves time, expense, and controls beyond the exigencies of the occasion. Many of these problems may be solved by reference to an established principle of science.

For example, a case is suggested by that of eating bread to reduce weight. The principle involved is that excesses of carbohydrate foods tend to develop fat in the tissues. All breads are largely carbohydrate. Therefore the claim is unsound. Any change produced in baking the bread would still leave it carbohydrate, perhaps more readily digestible, but still starchy, or sugary and starchy.

Another case is as follows. A principle of electricity is that an electric current will take the shortest path to complete a circuit. In power lines the shortest way to a complete circuit is often to the ground. Application is as follows. Heavy metal plumbing in an ordinary bathroom is grounded through the water pipes. Electrical apparatus used near plumbing presents extra hazards. An electrical immersion water heating device used in a bathroom is an extremely dangerous contraption. An acquaintance of the speaker, a man highly trained in science, was killed in his own bath as a result of a failure to make the foregoing application. Or if you prefer, he attacked the problem by the layman's experimental method and lost his life in the process.

John Citizen does not always take his life in his hand if he chooses to experiment. There are very many problems which do lend themselves to experimentation. Please note, however, that since the citizen's problems are most often problems of application, his experimental methods tend to be those of the applied sciences. They are more nearly allied to medicine, agriculture, applied psychology, education, and practical engineering.

The following kinds of experimental attack are most often useful:

a. The repeated application of the same treatment to the same subject under the same or very similar conditions
b. A control or check involving the application of two treatments, one to each of two groups of subjects, under the same or nearly the same conditions
c. A rotation experiment, involving the application of two treatments alternately, over several periods of time, to the same subject under the same conditions

d. **The application of a described treatment under carefully described conditions, with a full record of apparent results. This is the case method of the physician.**

The details of all of these experimental methods are too many to illustrate in full here. It should be noted, however, that there are differences in the techniques and that there are reasoning processes involved. Pupils in the sciences should be trained to chose techniques applicable to a problem and to do the reasoning implied.

Many of the problems of the layman are beyond his scope for experimental, or other, solution. He must solve such problems by reference to a proper authority. Is the pain in the abdomen appendicitis or will it yield to rest, warm water, and fasting? The wise man chooses the best physician he can find. He does not ask the soda clerk in the drug store, nor approach a "doctor" from a short term diploma mill medical school.

The solution of problems by reference to authority presents the very practical problem of how to choose an authority. This applies not only to doctors, and garage mechanics, but also to books and periodicals.

A scientific appeal to authority often implies a cross-check by a comparison of two or more authorities. Cases in which this may happen are obvious.

The question of the reliability of some proposed solutions to problems may sometimes be settled by a scrutiny of the measurements used in arriving at the proposed solutions. The layman needs to learn to critically review the measurements involved in the solution of problems. Two cases will serve as illustration. A sufferer from arthritis has taken so many bottles of an advertised mineral water and has recovered. What is the measure of the degree of recovery? The question of the germicidal value of certain widely advertised antiseptics hinges upon the question of the reliability of the measures involved.

If we are to accept this analysis as suggestive of the processes to be included in scientific methods for the layman, the need for a definite group of trainings becomes obvious. A suggestive list of the most needed areas of training for the development of abilities to use these scientific methods follows.

TRAININGS WHICH MUST BE UNDERTAKEN IN ORDER TO ENABLE CITIZENS TO BE ABLE TO APPLY SCIENTIFIC METHODS

1. **Training in the analysis of common and homely problems. Location and definition of the essential factors in a problem**

2. Training in the interpretation of the significances of scientific experiments
3. Training in the recognition of and the selection of authorities
4. Training in the use of reliable sources of scientific information
5. Training in discrimination between reliable and unreliable sources of information
6. Training in the formulation of "reasonable hypotheses" based upon established facts and principles
7. Training in the reading of science materials
8. Training in the interpretative reading of tables of data, graphs, diagrams, etc.
9. Training in the use of techniques of problem solving most often useful to the layman, e.g.
   a. Checking proposed solutions to specific problems by reference to established generalizations or principles
   b. Experimental verification by repeated trials
   c. Experimental verification by rotation
   d. Experimental verification by the use of control experiments
   e. Use of the case method of verification
10. Training in the use of an authority
11. Training in comparison and cross checking of authorities
12. Training in the use of at least some of the tools of scientific measurement
13. Training in the estimation or prediction of an error of measurement and the significance of such an error
14. Training in the selection of suitable measures for particular problems
15. Training in distinguishing cases calling for experimental verification; cases calling for verification by check with established principles; and cases calling for verification by appeal to authority

If such trainings as these could be established by schools in the younger generation, or with adults through current means of adult education, we might indeed begin to make use of such science as we now have or may accumulate in the near future.

If a training program from this point of view is to be undertaken, a direct attack upon the attainment of these trainings must be made. It would seem obvious that we cannot hope to develop such trainings by assuming that they accrue as a result of the dry-as-dust routines based upon the solution of the stereotyped problems of the present school laboratories. Individuals being trained must have practice in the operations called for in current life. If we do not carry out such a practice program, scientific method will become a glittering tool in the hands of twentieth century charlatans for the further bewilderment of the helpless citizen. Education in science instead of becoming a shield and a protection will become a snare for its possessor.

ELECTROLYSIS OF WATER

By F. Joseph Lorz

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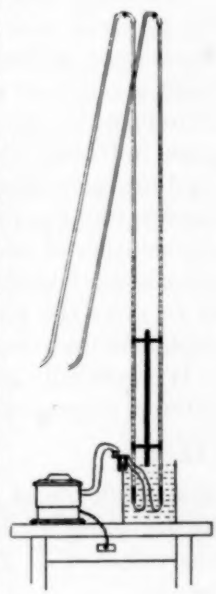
The demonstration of the electrolysis of water by the use of the usual apparatus designed for the purpose has in the experience of the writer presented two difficulties. These are the length of time required for the gases to evolve in quantities sufficient to produce readily visible results and the fact that, from the point of view of effectiveness as a demonstration, the size of the apparatus limits the range of observability by a class.



The objections may be obviated by the use of a simple set up here described. Two shipment length glass tubes (about 5 ft. long by 8–10 m.m. outside diameter) are mounted vertically to a lecture table standard, parallel to each other and supported at two points by double test-tube clamps. The electrodes used may be either those belonging to the manufactured apparatus or those made from copper or platinum. They are inserted into the bottom end of each of the tubes and the tubes lowered into a jar of water to which some sulphuric acid has been added for catalysis. To the top end of each tube is connected a rubber hose, which may be constricted with a pinch-cock near the union. A convenient method of filling the tubes is to draw up the water with the mouth. Another method of doing this is to seal or cork one end of the tubes, fill with water and invert.

When a tungar rectifier is used as a source of current, the results are brilliant. Because of the small bore of the tubing a relatively small evolution of gas produces a rapid and readily noticeable change in levels. At the cathode, evolution of hydrogen in sufficient quantity to fill the tube completely can take place in two or three minutes, and instead of dealing in centimeters in measurement of levels, it is easily possible to deal in feet.

A METHOD OF DETERMINING THE SIGN AND VALUE OF I^n, WHERE I EQUALS $\sqrt{-1}$ AND N IS ANY RATIONAL POSITIVE INTEGER EQUAL TO, OR GREATER THAN TWO

By L. R. Posey

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This paper attempts to set forth in a very plain and clear-cut way the ease with which the sign and value of i^n can be determined without committing to memory the paradigm generally given in college algebras and in high school algebras which introduce the imaginary number. The directions and formulas given in this article pertaining to imaginary numbers have been used for more than two years by the writer in his college algebra classes, and they have added interest, speed, and accuracy to the solution of such exercises. The purpose of this article is to show a quick and accurate way of obtaining the sign and value of i^n, after the properties of i have been carefuly studied and explained up to and including i^5.

It is generally conceded that the imaginary unit grew out of an attempt to generalize the quadratic equation

$$X^2-1=0. \tag{1}$$

Most high school pupils know that this equation can be solved by factoring, or by transposing the negative one and finding the values of X. The equation written in the factored form will be:

$$(X+1)(X-1)=0. \tag{2}$$

Since the product of these two factors is zero, either of them may be made equal to zero, in which case the values of X will be 1 or -1. Or, if we transpose the negative one in equation (1), we will have

$$X^2=1. \tag{3}$$

Extracting the square root we get

$$X=\pm 1,$$

just as we did before.

Now when the ancient mathematicians attempted to solve

$$X^2+1=0, \tag{4}$$

they found a difficulty which lasted for about two hundred years, before any satisfactory agreement could be reached. This period lasted from about the middle of the sixteenth century, when Cardan solved a problem containing imaginary roots, until about the middle of the eighteenth century, when Euler used i to represent $\sqrt{-1}$. The imaginary unit and hence imaginary numbers were looked upon as fictitious, impossible, imaginary, whence the name imaginary numbers.

To solve $X^2+1=0$, it was necessary to introduce a new unit, $\sqrt{-1}$, into the number system. This new unit represented by i extended the number system so that the even roots of negative numbers can be found. We know now that the imaginary unit is just as real and useful as -1 or any other negative number. This imaginary unit enables us to solve all types of equations in the general quadratic form $(ax^2+bx+c=0)$.

Now let us note the interpretation and behavior of the imaginary unit as it passes from the second to the fifth power. Let

$$i=\sqrt{-1}$$

Then

$$i^2=-1$$
$$i^3=-i$$
$$i^4=1$$
$$i^5=i.$$

From this point on, the consecutive powers of i will repeat themselves. That is,

$$i^6=-1$$
$$i^7=-i$$
$$i^8=1$$
$$i^9=i$$

and so on, in cycles of four.

With this interpretation of i, we are now in position to solve:

(5) $$X^2+1=0.$$

Transposing $$X^2=-1$$

$$X=\pm\sqrt{-1}=\pm i;$$

that is, i and $-i$ are roots of equation (5). If

$$X^2=-4$$
$$X=\pm\sqrt{-4}=\pm 2i,$$

and so on for any indicated even root of a negative number. If we write the scale of the new number system, it will look as follows:

$$\cdots -2i,\ -i,\ 0,\ i,\ 2i \cdots.$$

We must not wander too far from what we started out to show; namely, to write the value of i^n, after the above interpretation of i from the second to the fifth power is given. Ordinarily, the student will not remember the sign and value of i^5, say, unless he refers to the paradigm above, or begins with i^2 and writes down to i^5. Offhand, he does not remember whether i^5 is positive i or negative i, and some of the students will not know whether i^5 is real or imaginary. Hence, special attention should be called to the fact that all even powers of i are real, and all odd powers of i are imaginary. Running through the paradigm above, we see that all even powers of i are real, and that all odd powers are imaginary. The student should definitely fix this important fact in his mind.

An examination of the even powers of i reveals the following facts:

$$i^2 = -1$$
$$i^4 = 1$$
$$i^6 = -1$$
$$i^8 = 1$$

and so on. Observe that every other sign of the even powers of i is positive; that is, beginning with i^2, we have alternately, negative one, positive one, and so on to any desired power. In like manner, the odd powers are:

$$i^3 = -i$$
$$i^5 = i$$
$$i^7 = -i$$
$$i^9 = i$$

and so on.

To determine whether i^n is one, negative one, i, or negative i is our next step. Notice that if we divide the even powers of i, beginning with i^2, by two, we get odd and even quotients, corresponding respectively to negative one and positive one. Hence the rule: If n is even, we have the real unit, one, and it is positive or negative according as the quotient of the power is even or odd when it is divided by two. For instance,

$$i^{24} = 1,$$

for 24 is an even number and $24 \div 2$ gives 12, an even quotient. This rule checks with the value of $i^4 = 1$ in the paradigm above; for $4 \div 2$ is 2, an even quotient, and hence, according to our rule, i^4 should, and does, equal one.

Again

$$i^{22} = -1,$$

for $22 \div 2$ is 11, an odd quotient. The rule checks with the value of $i^2 = -1$ in the paradigm, for $2 \div 2$ is one, an odd quotient.

The next step is to show how to determine the sign and value of i when n is *odd*. Referring to the paradigm above, we see that negative one is followed by negative i, when the powers are taken in succession beginning with i^2. By the rule, then, for determining the sign and value of i when n is even, it follows that, if $(n-1) \div 2$ is odd, i^n is *negative* i, and that, if $(n-1) \div 2$ is even, i^n is *positive* i. For example:

$$i^{23} = -i$$

for $(23-1) \div 2$ is 11, an odd number. The rule holds for the known value $i^3 = -i$; for $(3-1) \div 2$ is one, an odd number. In like manner, $i^5 = i$ and $i^{17} = i$. We are now prepared to write the sign and value of i^n at once, whether n be even or odd.

We shall now put into symbolic language all which has been said relative to raising i to any power. With a little practice, the following formulas will enable the student to write, at once, the correct sign and value of i^n, where n is any rational integer equal to, or greater than 2. These formulas are useful in any branch of mathematics which uses the imaginary unit, $\sqrt{-1}$. Since the formulas give the correct sign and value of any power of i from *two* up, they may be substituted for the paradigm given above once the student understands the behavior and meaning of the imaginary unit. That is, the student will not have to commit to memory the paradigm above; he simply reads it through understandingly and then applies the rules given in this article. These rules are so simple that repeating them once or twice will usually fix them in the student's mind, especially when they are used in connection with a few exercises. The formulas are as follows:

(1) $i^n = 1$, if n be *even* and $n \div 2$ be *even*.

(2) $i^n = i$, if n be *odd* and $(n-1) \div 2$ be *even*.

(3) $i^n = -1$, if n be *even* and $n \div 2$ be *odd*.

(4) $i^n = -i$, if n be *odd* and $(n-1) \div 2$ be *odd*.

TEACHING SCIENTIFIC METHODS
Article VI

By Francis D. Curtis
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The recent movement toward a simplification and a clarification of the aims of science teaching at all levels has focused an increasing amount of attention upon the scientific attitudes and the scientific methods. The need for clearly differentiating these major objectives by defining them is patent, since obviously there can be no effective progress toward their attainment until they have been clearly defined.

Considerable progress has already been made toward the determination of scientific attitudes. The first list determined by research was published ten years ago. Several investigators and writers have since contributed additions and modifications so that there are now available definite statements of a considerable number of scientific attitudes which serve as a practical basis for classroom activities designed to develop these attitudes. There is evidence, however, of the need for a similar list of scientific methods or of elements or phases of scientific method, as one may prefer to designate them.

Important pioneer work on scientific methods has been reported by Downing[1] and by Tyler.[2] Moreover, the recent series of articles by Davis,[3] LeSourd,[4] Downing,[5] and Beauchamp,[6] aiming at a definition of scientific methods constitute a unique and valuable contribution. An analysis of these various discussions indicates clearly that while scientific attitudes and scientific methods are of necessity closely related and inseparable, they are nevertheless distinctly different concepts. Their relation may perhaps be expressed in the statement that scientific attitudes are essential in the employment of scientific methods

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[1] Downing, Elliot R. "The Elements and Safeguards of Scientific Thinking," *The Scientific Monthly*, XXVI (April, 1928), 231–243.

[2] Tyler, Ralph W. *Constructing Achievement Tests*, Columbus, Ohio. The Ohio State University, 1934.

[3] Davis, Ira C. "Is This the Scientific Method?" School Science and Mathematics, XXXIV (January, 1934), 83–86.

[4] LeSourd, Homer W. "Teaching Scientific Method." School Science and Mathematics, XXXIV (March, 1934), 234–235.

[5] Downing, Elliot R. "Teaching Scientific Method." School Science and Mathematics, XXXIV (April, 1934), 400–405.

[6] Beauchamp, Wilbur L. "Teaching Scientific Method." School Science and Mathematics, XXXIV (May, 1934), 508–510.

and that the employment of scientific methods contributes training in scientific attitudes.

One means of determining a list of scientific methods is to analyze incidents in the history of science in which are described in detail the steps by which the masters of science arrived at their most important discoveries or achieved their epoch-making inventions. Such an analysis reveals the following techniques which seem to be definitely and characteristically scientific methods as distinct from scientific attitudes. All of these techniques, however, are not mutually exclusive, nor is it reasonable to believe that this list is complete or necessarily valid with respect to all its items.

SCIENTIFIC METHODS

1. Locating problems.
2. Making hypotheses, or generalizations, from given facts or from observations.
3. Recognizing errors and defects in conditions or experiments described.
4. Evaluating data or procedures.
5. Evaluating conclusions in the light of the facts or observations upon which they are based.
6. Planning and making new observations to find out whether certain conclusions are sound.
7. Making inferences from facts and observations.
8. Inventing check experiments.
9. Using controls.
10. Isolating the experimental factor.

When the articles on scientific methods, to which reference has already been made, are analyzed in terms of this list, they are found to exemplify many of the techniques here designated as "Scientific Methods." Thus, Downing's discussion of the elements and safeguards of scientific thinking includes locating problems, making hypotheses from observations, planning and making new observations to find out whether certain conclusions are sound, and evaluating data and procedures. Tyler's monograph gives instruction in making inferences, hypotheses, or generalizations from facts and observations. Davis' discussion involves controls, and variables (implying an experimental factor), planning observations, recognizing errors in experimentation, locating problems, and drawing conclusions from data. LeSourd's article illustrates locating problems, introduc-

ing controls, isolating the experimental factor, and drawing conclusion, from data. Downing's second article stresses making hypotheses and inferences from observed data, locating problems, planning and making observations, and planning check experiments. Beauchamp's discussion includes evaluating data and procedures, making inferences from facts and observations, introducing controls, and isolating the experimental factor. Perhaps other scientific methods less easily recognized and designated are also implicit in these articles.

Each of these articles gives one or more excellent examples of classroom techniques by which scientific methods may be taught. The suggestions which follow, therefore, are intended merely as additional specimens of classroom exercises each of which is aimed definitely to teach certain of the scientific methods by focusing the attention of the pupils directly upon these methods as designated in the list. It is hoped that connecting the method or technique employed with a name more or less appropriate to it may assist the pupil in learning the scientific methods more quickly and certainly.

1. The process by which the items on the above list of "Scientific Methods" were obtained, namely that of analyzing stories of scientific discovery and invention may be reversed, thus: With the list of scientific methods before him, the pupil may read accounts of such classics of science as Pasteur's work on anthrax or on hydrophobia; the story of the discovery of Neptune or Pluto; a description of Edison's attack upon the problem of inventing the incandescent lamp, and the like. As he reads he may indicate which steps in the story specifically illustrate various of the scientific methods on the list. Thus he would designate certain statements in the account which describe locating problems, setting up controls, inventing check experiments, formulating hypotheses, etc.

2. The pupil may be given training on specific methods such as the formulation of inferences and hypotheses from data, in the manner suggested by Tyler,[7] of which the following are typical illustrations:

Twenty fertilized hens' eggs were divided in two groups of ten eggs each. The one group of ten eggs was kept at 100 degrees F. for three weeks. The second group of ten eggs was kept at 40 degrees for three weeks. Air and moisture conditions of the surroundings of both groups were suitable for hatching. What will be the result at the end of three weeks and why?

[7] Tyler, Ralph W. *Constructing Achievement Tests*, Columbus, Ohio: The Ohio State University, 1934.

Two live frogs each weighing 60 grams are selected and two small crayfish each weighing 20 grams are also selected. One crayfish is fed to each frog. The frogs are kept at 60 degrees F. for three hours and then one (1) is put in the ice chest at 40 degrees F. and the other (2) is kept at 80 degrees F. in a warm room. What differences will be found in the state of digestion of the crayfish at the end of 48 hours, and why?

3. Laboratory exercises and problems involving experimental techniques may be made to provide training and drill in various of these scientific methods to which the pupil's attention is specifically directed. These are examples:

a. Problem. Does the addition of manganese dioxide to potassium chlorate increase or diminish the speed with which oxygen is given off when potassium chlorate is heated?

Procedure. Fill a small test tube half full of a mixture of three parts of potassium chlorate and one part of manganese dioxide. Fill another *exactly similar* test tube equally full of potassium chlorate. Set up each of the test tubes as in Fig. 1. Heat the mixture in the first test tube by passing the flame from the burner over it for a minute. Collect all the gas which is given off. Then heat the second tube which contains no manganese dioxide in *exactly* the same way as you heated the first, and for *exactly* the same length of time. Collect all the gas which is given off. Compare the quantities of gas secured from the two tubes.

Conclusion. Answer in a sentence the question asked in the problem.

Exercise of scientific methods. What was the control in this experiment?[8] What was its value in the experiment? What was the experimental factor?[8]

b. *Invent an experiment* by which you might determine whether tin or lead is the better conductor of heat. List all the steps. Shall you need to introduce a separate *control* in this experiment? Explain.

c. John connected an electric bell to one dry cell. The bell did not ring. He connected the bell to two dry cells in series and the bell rang. He concluded that two dry cells are required in order to make an electric bell ring. *Evaluate his conclusion* by stating whether his conclusion was justified from his experiment. Justify your answer, stating as many reasons as you can. How should you proceed to find out by experimenting whether or not his conclusion was sound? List all steps in your *check experiment.*

d. Suppose you discover ants in your kitchen. What questions or *problems can you suggest* which would need to be answered or solved before you could expect to get rid of the ants or to prevent more ants from entering your kitchen?

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[8] A control in an experiment is any condition which gives a basis for comparison. Every factor in the control is exactly like that in the experiment itself except *one*. This one factor which is different is called the *experimental factor*.

TUBERCULOSIS FOUND IN WILD MOOSE

A rare case of animal tuberculosis was found at Balaryd, in the Swedish province of Smaland, where a wild moose was recently ordered killed by the local sheriff. The animal, looking weak and emaciated, had repeatedly come out of the forest and kept close to a gang of workmen building a road. One day the moose lay down on the road, and was unable to rise again. It was then shot. The carcass was examined and it was found that the animal suffered from tuberculosis in a very advanced stage.

RESEARCH FOR HIGH SCHOOL STUDENTS

By Charles H. Stone
Boston, Massachusetts

The laboratory is the place in which the chemistry student demonstrates his ability to set up apparatus, to follow directions, to observe accurately and to reason from observed results correctly. Nowhere else is his power, or lack of it, so well shown. In the laboratory he should learn to stand upon his own feet.

The usual textbook in our preparatory schools gives in much detail the properties of the common elements and their chief compounds. The student who goes to the laboratory to prepare any of these substances knows beforehand what he is to obtain as a result; he knows that the sulphur dioxide he is about to prepare will be a colorless gas with choking odor, and which will not burn; he knows that the ammonia gas he is about to produce will have a remarkable solubility in water and will not support combustion. It seems almost too bad that our writers of texts and manuals give so much information which the student might easily discover for himself. The joy of making one's own discoveries is destroyed by the completeness with which every detail is set forth in the text and manual. Under such conditions, the pupil becomes merely a verifier rather than an investigator, and the chief value of laboratory work may lie in the acquirement of certain skills in setting up and operating apparatus. To offset this condition, some work of an investigative character (research work) may now and then be advantageously used.

The word "Research" in the ordinarily accepted sense is applied to a more or less extended investigation in some field of knowledge not yet thoroughly explored with a view to bringing new facts to light and extending the range of knowledge in some particular direction. Work of this sort is obviously far beyond the ability of the average High School student. The word "Research" in the heading of this article is to be understood to mean the investigation of some simple problem, already well enough understood by the chemist and the teacher, but which is new to the student and which he does not find explained in his text or manual. Such problems must be selected as having direct bearing upon the immediate topic and must not be beyond the ability of the student to solve. A few such are listed below.

Mercuric oxide, when heated, yields mercury and oxygen. Will other simple oxides (zinc oxide, magnesium oxide, copper oxide), act similarly when heated? Why?

Manganese dioxide acts as a catalyst when heated with potassium chlorate. Will other dioxides (silicon dioxide for example) also act in this way when heated with potassium chlorate?

How would you obtain in pure dry condition, the substances left in the generator after preparing oxygen from a mixture of potassium chlorate and manganese dioxide?

Could the manganese dioxide, used once as a catalyst, be used a second time with potassium chlorate?

Will manganese dioxide act as a catalyst on fresh hydrogen peroxide? When barium chlorate is heated, does it give off its oxygen slowly or all at once? Why is barium chlorate not used for oxygen preparation? Is cost a factor?

Once cc of potassium chlorate will liberate, when heated, 685 cc of oxygen at N. T. P. What pressure would be required to squeeze the 685 cc of oxygen back to a volume of 1 cc? Why are chlorates classed as dangerous chemicals?

Which acts most vigorously on water, calcium, potassium, or sodium? Will amalgamated aluminum act on water? What gas is formed if any?

Could copper be used in place of zinc in the preparation of hydrogen? Could iron be used? Why in each case?

Sulphuric acid contains two atoms of hydrogen per molecule while hydrochloric acid contains only one atom of hydrogen per molecule. Given 13 grams of zinc, which acid would you use to get the more hydrogen? If 18 grams of water in form of steam be passed over hot zinc, two grams of hydrogen are set free. If 18 grams of water react with sodium, will two grams of hydrogen be formed? Why?

Will a silver coin dissolve in concentrated hydrochloric acid? Why?

In the reaction between a metal and an acid, does the liberated hydrogen come from the acid or the metal? How do you know?

A plumber uses a mixture of aluminum filings and solid sodium hydroxide to clean out a sink pipe, adding water to the mixture. What is the chemical reaction? Where does the hydrogen come from in this case?

If the sink pipes are of lead, is there any objection to the use of such a mixture? Why?

How would you show that sodium hydroxide contains hydrogen? When copper is obtained by reduction of the oxide, the reduced copper must not be poured out of the reducing chamber till the metal is cold. Why is this?

Which contains more energy, one gram hydrogen and eight grams oxygen separately or nine grams water? Why?

Can hydrogen be produced by the action of steam on hot copper? Why? Will copper dissolve in dilute sulphuric acid? In concentrated hydrochloric acid?

As progress is made to other topics than those indicated above, other questions will be suggested. No one pupil should perhaps, be expected to solve all of the problems that may thus arise but every pupil should have a chance at some of them. The idea, of course, is to stimulate the investigative faculty and to encourage independent thinking. The inability of some students to solve even the simplest of problems like those given above, shows how dependent they have become upon the text and the manual. A few such problems solved independently are worth more than an equal or larger number of others taken from the manual experiments.

The capable teacher will be able to think up any number of similar problems for use as occasion may require and the class advances.

THE SYMBOL SPREE

By Earl C. Rex, *Grays Harbor Junior College, Aberdeen, Washington*

Many times mathematics beginners make the mistake of transposing a term without changing the sign. Quite often, also, a student will treat a term as a factor, or a factor as a term. The following verse is a pleasant reminder of these mistakes. Read it to your students! They may forget the rhyme, but the scent(-iment) lingers on.

Oh, cruel fate that I should see
A letter on a symbol spree!

A spree in which its sign it keeps
Though over equals signs it leaps.

A factor, like the hapless worm,
May turn, and change into a term.

Or if a term, then like an actor,
Its costume shifts and . . . is a factor!

The drunken letter reels and trips
Through algebraic curves and dips.

Prohibition or not, I often see . . .
A letter on a symbol spree.

AN EXPERIMENT ON TORQUES

For the Elementary Laboratory

By M. H. Trytten
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Among laboratory experiments designed for an introductory course in Physics one usually finds an experiment on moments of force or torques. Usually the apparatus consists essentially of a graduated bar, or meter stick from which are hung weights at various places.

Such an experiment has a glaring defect. Usually students blithely learn that a torque is the product of a force times the distance to the axis of rotation. The essential point that this distance must be measured in a perfectly definite way, that is, in a direction perpendicular to the line of action of the force, is not

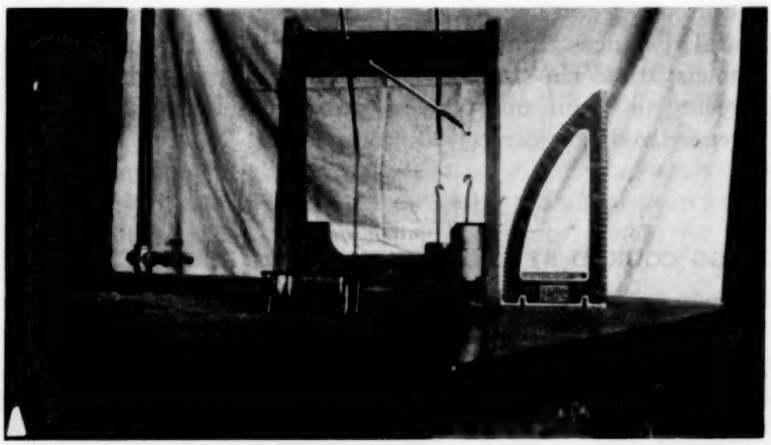

FIG. 1. Apparatus for the Equilibrium of Torques.

always readily assimilated. The above mentioned experiment actually does nothing to remove the misapprehension, because the distances involved in the experiment are measurable directly on the bar.

The experiment herein described was intended to obviate this difficulty. The apparatus is readily understood from the cut, Fig. 1. It consists essentially of a cylinder with a narrow pin at

each end, the pins resting in brass bearings held by the two uprights at the ends. The cylinder is thus free to rotate easily about its axis. Holes are drilled through it centrally, at various points and at various angles with the axis. Through these holes are passed threaded rods, which are bent into a hook at one end, and which can be locked in position, at any desired length, by nuts. Weights may now be hung from these hooks. The system will automatically acquire equilibrium.

For the measurement of the "distances," or moment arms it has been found advantageous to prescribe a direct method first. A large right angle is held by the student as closely as he can judge equi-distant with the line of action from the axis and the moment arm is then measured directly. The method is not accurate of course, but serves in a very forceful way to bring home the idea of the moment arm.

A second and much more accurate method is then suggested. A fine piano wire is mounted on the apparatus vertically below and parallel to the axis of the cylinder. The weights are hung not directly from the hooked rods but by fine threads. The horizontal distances from the piano wire to the threads are the moment arms. The students have no difficulty in getting results agreeing to within one percent, provided the moments of the threaded rods are correctly accounted for.

EGG COOKED BY RADIO WAVES FROM THE INSIDE OUT

Professor Jellinek, French scientist, placed a raw egg between two condenser plates connected to a short wave radio transmitter. The power applied was 1000 watts, the wavelength 3 meters. After five minutes exposure, the yolk of the egg was found to be cooked hard and solid, but the white was scarcely affected, being only of the consistency of jelly. Thus the egg was cooked from the inside out. Yet the temperature of the yolk at the end of the cooking was only 140 degrees Fahrenheit, while that of the white was 176.

This experiment was not performed as a stunt, but as part of a serious and extensive research on the effect of short radio waves on different organic tissues, which Professor Jellinek recently reported to the Paris Academy of Sciences.

The eye of an ox was similarly experimented upon, and it was found that while the crystalline lens was little affected, other parts of the eye were greatly affected.

It is important to study this selective action of the waves, and their different heating effects on different tissues, Professor Jellinek said, because of the recent use of short waves for therapeutic purposes.—*Science Service.*

ATOMS IN ACTION

No. II. Construction and Destruction of Atoms

By W. T. Skilling
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The discovery of isotopes revived an old theory that atoms of all elements are made up of larger or smaller number of atoms of the lightest element, hydrogen. More than a hundred years ago Prout proposed this theory after noticing that many of the elements had an atomic weight of very nearly some whole number, counting the atomic weight of hydrogen—one. He thought that perhaps errors in finding the correct atomic weights accounted for the fact that all atoms were not *exactly* multiples of the weight of hydrogen.

But later as more precise means were used in finding atomic weights Prout's theory had to be abandoned for the weights would not come out exactly whole numbers, and some of them, as chlorine, were about as far as possible from being whole numbers.

Still later the discovery of isotopes explained fractional atomic weights. Hydrogen atoms may well be the building blocks out of which atoms of chlorine weighing either 35 or 37 times as much as the hydrogen atom are made. And a mixture of these two kinds of chlorine atoms might easily give an average weight of 35.46, or any other fractional number for the mixture.

If it seems incredible that there should be two kinds of chlorine atoms, both acting exactly like chlorine, we have but to remind ourselves that it is not the *weight* of the atom that determines its chemical behavior but the electric charge on its nucleus, and the number and arrangement of the electrons that surround the nucleus. Both these isotopes of chlorine have a net positive charge of 17 on their nuclei, and therefore 17 encircling electrons.

There is nothing now to contradict the theory that all atoms, heavy and light may be made up of hydrogen, or at least of combinations of particles of the weight of electrons and particles as heavy as the hydrogen nucleus, the "proton."

THE LAW OF RADIOACTIVE CHANGE

When it became known that the change taking place when a

radioactive atom exploded was either the loss of an alpha particle or a beta particle, that is, a helium nucleus or an electron it became easy to predict what the resulting atom would be, and its weight. For instance when radium throws off a helium nucleus, as it does, it loses 4 in atomic weight and is less positively charged by 2, for the part thrown off weighs 4 and has 2 positive charges. These changes put it into a certain position in the periodic table of elements, automatically fixing its chemical behavior. Radium with a nucleus weighing 226 and possessing 88 positive charges cannot lose a helium nucleus without reducing itself to a weight of 222 and a positive charge of 86, which puts it in the zero column of elements the column of inert, no valence elements.

On the other hand if an atom expels an electron, a beta particle, its weight is not changed perceptibly, and its nucleus out of which the electron came is made one charge less negative, that is, one charge more positive. Thus the element actinium parts with an electron making its nucleus one charge more positive. This gives it the same charge as the element thorium. Having the same charge as thorium makes it an isotope of that element and therefore identical with thorium chemically though it still has the lesser weight of actinium. It has lost the chemical properties of actinium as thoroughly as a butterfly has lost the characteristics of the caterpillar from which it came. (See diagram p. 741, School Science and Mathematics, Oct. '34.)

EVIDENCE AND EFFECTS OF RADIOACTIVITY

PHOTOGRAPHIC EFFECT

The ways in which radioactive substances make their presence known is well illustrated in the story of their discovery in 1896 by Henri Becquerel. It was only a few months earlier than this that X-rays had been discovered by Röntgen. Becquerel and others thought that possibly the penetrating X-rays came from the fluorescent glass of the globe used in producing them. So a number of fluorescent substances were exposed to the sun and tested to see if they would emit rays that would pass through opaque material. These experiments met with no success until Becquerel tested a uranium compound. It was placed close to a photographic plate with a small silver disk between it and the carefully wrapped photographic plate. On developing the plate it was found that some sort of rays had gone through

the wrapping, as X-rays would have done and had acted on the plate except where the silver covered it. Later Becquerel found that previous exposure to sunlight was unnecessary and that any uranium compound or the metal itself would act like X-rays both photographically and in discharging an electrified body such as pith balls or a gold leaf electroscope. The effect of as little as a billionth of a gram of radium can be detected by the electroscope.

It has now come to be recognized that the electrical effects are due to the air being ionized by either the alpha particles, the beta particles or the gamma rays. That is, the electrons of air molecules among which they pass are knocked off, leaving the air electrically charged. At first all three of these emanations from the radio substance were spoken of as rays and the name still persists though it is only the gamma rays that are at all analogous to light.

LIGHT PRODUCING EFFECT

Besides the photographic and electric effects of radioactive materials the alpha particles cause a splash of light when they strike a zinc sulphide screen. That is, they produce radiation of such a wave length as can affect the retina. It is this effect that is employed in making figures on a watch face luminous. The splashes of light, if slow enough, can be counted, and thus the rate of disintegration timed. On a watch face there is so much of the radioactive material that only a slight trembling, visible in the dark, indicates that the source of light is not continuous.

Taking advantage of the power of the rays to ionize the air and thus to cause more easy flow of electricity through the air a counter has been made that shows by a kick of the galvanometer each time an alpha particle is shot through a small hole into the instrument from a little of the radio substance. The instrument has an electric circuit except for an air gap across which the current just barely cannot flow with the voltage it has. But whenever an alpha particle enters and ionizes the air in the gas a quick surge of current passes, disturbing the galvanometer. Thus knowing the number of particles that enter the hole in a given time, the size of the hole, and the distance to the sample of radioactive matter the total number of explosions can be calculated.

HEATING EFFECT

The heat caused by absorption of the energy of the flying particles and the penetrating gamma rays from radium and its products is so great as to keep it and its container one or two degrees higher than the surroundings. About 90% of this heat is due to the alpha particles, the helium nuclei. One gram of radium (together with its short lived products of transformation) gives off 137 calories of heat per hour. It can be calculated that the total amount of heat that would be produced by the "decay" of one gram of radium is 3.7×10^9 calories. Put into more easily understood terms it is enough heat to raise about 40 tons of water from the freezing point to the boiling point. This is about a million times as much heat as would be produced by the uniting of a gram of hydrogen and oxygen in the process of burning.

PHYSIOLOGICAL EFFECT

The medical use of radium is well known, and also the danger attending its use. Like X-rays the emanations of radium cause burns which are not felt at the time but afterwards develop into sores often hard to heal. The alpha particles are checked by a metal film or even paper, but the faster moving electrons, beta "rays," are more penetrating. To stop gamma rays the radioactive material is kept in lead containers. Any of the three so called rays are dangerous, and therefore radium like X-rays should be entrusted only to specialists who understand their effects and the method of avoiding danger.

COLLEGE OF SURGEONS SUPERVISES CARE OF ACCIDENT VICTIMS

A recent annual report indicated that the casualties in this country, among workers in industry, numbered 19,000 killed, and 2,500,000 lost-time injuries without death. Approximately 32,500 were killed in automobile accidents, and over 1,000,000 were injured.

These appalling facts caused the American College of Surgeons to initiate its study of industrial medicine and traumatic surgery by calling a conference of outstanding lay and medical leaders in industry, in labor, in indemnity insurance, and industrial physicians and surgeons. A minimum standard was perfected and clinics which specialize in industrial medicine and traumatic surgery are under survey by the College to determine those that are equipped to give proper service.

It is a stupendous task; but with the support of the public—employers and employees—the economic saving will amount to millions of dollars, many lives will be spared, and thousands of potential cripples will be restored to perfect health.—*Science Service.*

SUBJECT MATTER TOPICS IN BIOLOGY COURSES OF STUDY

By Norman E. Webb and W. G. Vinal
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The aim of this study is to determine the nature of subject matter found in present day courses of study in Biology. The study was made from thirteen courses of study in Biology which were chosen from widespread sections of the United States. Each bulletin was from a recognized curriculum center. None of the courses was more than three years old, thus making the survey a study of very recent trends.

The procedure used in this study was to list on small slips of paper all of the main headings, topics, and sub-topics found in the thirteen courses of study selected. In the left-hand corner of each slip of paper we placed, as the case demanded, an M (main heading) a T (topic) or an S (sub-topic). In the right-hand corner of each slip a number was placed to indicate the source. (See key.) The subject matter fell into about twelve general headings. The related topics and sub-topics were grouped under these twelve main headings.

Our study reveals that the practical and interesting topics in biology are being stressed. Highly technical matters not directly pertaining to everyday life were either omitted or not as frequently used as the more practical topics. For example, "Lower Plant Life" doesn't receive as much space as the division called the "Living Green Plants." It is also interesting to note that in the "Lower Plant" division Bacteria receive the most attention and are mentioned in nine courses of study, while the topic of Rusts and Smuts only receive mention in two courses. Another instance is found in the division called "Animals." The unimportant phyla in the animal kingdom received only slight mention in only four or five courses, while the Arthropoda (Insects) and Vertebrates were mentioned in detail in ten of the courses of study.

There seems to be a greater emphasis on social and economic aspects of biology. The main division entitled "Heredity, Environment, and Evolution" is perhaps the most far reaching of the entire survey. It is purely a trend towards the sensible and sane study of society. Eleven of the thirteen courses are represented in this division. The economic phase of this con-

clusion is drawn from the fact that a great many of the sub-topics read such as this . . . "Economic importance of . . . ," about nine of the courses constantly use this sub-topic heading in the study of many of the topics.

These two trends are more or less direct departures from many of the usual courses of study in biology. There is still a great chance for improvement along the lines of topics such as National Forests, Arbor Day, Nature Study, Recreation, Field Work, and Sex Education.

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I. CLASSIFICATION OF LIVING THINGS

	F*	
1. Historical background of classification methods.	2	3, 12
Animal classifications	2	3, 12
Plant classifications	1	3
2. Systems of classifications	11	1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13
Natural classification	7	2, 5, 7, 8, 12, 13

* F = frequency

Artificial classification	1	12
3. Naming living things	3	3, 4, 5
Need of scientific names	1	3
Common names	2	4, 5
Value of scientific names	2	3, 5
A newly discovered organism	2	3, 4
4. The plant kingdom	5	1, 2, 4, 7, 9
The four phyla of the plant kingdom	4	1, 2, 4, 7
Identification of plant individuals	1	9
Common groups of plants	2	4, 5
5. The animal kingdom	10	1, 2, 3, 4, 5, 7, 8, 9, 10, 13
The phyla of the animal kingdom	6	1, 2, 3, 4, 7, 13
Identification of animals	3	4, 7, 10
Common animal groups	2	5, 9
Man's place in nature	1	8

II. CELLS

6. Start of life from a single cell	1	13
7. Cell theory by Schleiden and Schwann	1	12
8. Cell structures and functions	8	1, 3, 4, 6, 7, 11, 12, 13
Sizes and shapes of cells	1	1
Cell wall	2	3, 7
Cytoplasm	3	3, 7, 12
Nucleus and nucleolus	4	3, 7, 12, 13
Tissues and organs	3	3, 6, 7
Division of labor	2	4, 7
Cell division	3	1, 4, 8
9. Protoplasm	9	1, 2, 3, 6, 7, 8, 11, 12, 13
Appearance and properties of	2	2, 7
Plant and animal cells	6	2, 3, 4, 7, 8, 11
Life functions based upon protoplasm	7	3, 4, 6, 8, 7, 11, 13
The inverse ratio of specialization and adaptability	2	6, 12
10. Life of single celled animals and plants	1	1

III. LOWER PLANT LIFE

11. Fungi	7	1, 3, 4, 6, 9, 10, 13
Kindsof fungi	5	1, 4, 9, 10, 11
Characteristics of fungi	2	3, 10
Economic importance of fungi	5	1, 4, 6, 9, 13
12. Mosses and ferns	8	1, 3, 4, 6, 9, 10, 11, 13
Characteristics of mosses and ferns	4	6, 9, 10, 11
Life history	4	3, 4, 6, 10
Economic importance	1	6
Comparison with other plants	1	1
13. Yeast	5	1, 3, 6, 10, 11
Yeast cultures	1	3
Reproduction in yeast	1	3
Relation of yeast to man	3	1, 3, 10
14. Puffballs, mushrooms, and toadstools	3	3, 6, 11
15. Rusts and smuts	2	1, 3
16. Molds	7	1, 3, 5, 6, 9, 10, 11
Structure of molds	1	3

Bread molds	5	1, 5, 6, 9, 10
Molds in cheese making	1	10
Damage done by molds	2	3, 10
17. Bacteria	9	1, 3, 4, 6, 7, 9, 10, 11, 13
Nature of bacteria	2	3, 11
Bacteria in the plant kingdom	2	3, 4
Bacteriology	4	1, 3, 4, 11
Distribution of bacteria	3	3, 10, 11
Types of bacteria	5	1, 3, 9, 10, 11
Life processes of bacteria	3	1, 3, 11
Control of bacteria	5	1, 3, 9, 10, 11
Useful bacteria	8	1, 3, 4, 6, 7, 9, 10, 13
Food preservation	3	7, 9, 10
Bacteria and disease	6	1, 4, 6, 9, 10, 11
18. Algae	6	1, 4, 6, 9, 10, 11
Kinds of algae	4	4, 6, 9, 11
Characteristics of algae	3	1, 6, 10
Division of labor in algae	1	1
Economic importance of algae	2	4, 6
19. Lichens	2	1, 6
20. Structures of lower plant life	4	1, 4, 9, 13
21. Reproduction in lower plant life	2	4, 13
Reproduction by spores	2	4, 13
Reproduction by cell-division and budding	1	13
Conjugation in lower plants and animals	1	4
Reproduction by vegetative methods	1	4

IV. THE LIVING GREEN PLANT

22. Plant ecology	7	1, 3, 4, 5, 7, 9, 10
Seed dispersal	6	1, 3, 4, 7, 9, 10
Plant's struggle for existence	3	4, 5, 9
Adaptations to environment	4	4, 5, 7, 9
Aquatic plants	2	4, 9
Barriers and zones	3	3, 4, 5
Hydrophytes, Xerophytes, and Mesophytes	2	5, 9
Economic phase of plant ecology	1	5
Island flora	1	4
23. Seed germination	8	1, 3, 5, 6, 9, 10, 11, 13
Dormancy of seeds	1	9
Stored foods in seeds	4	1, 6, 9, 10
Steps in seed development	4	3, 6, 9, 10
Moisture and seed growth	4	1, 3, 5, 9
Temperature and seed germination	4	1, 3, 5, 9
Soil and seed germination	1	9
Air and seed germination	4	1, 3, 5, 9
Sunlight and seed germination	3	3, 5, 9
Gravity and seed growth	2	3, 9
Seed testing	1	9
Adaptations of a young plant	1	9
24. Roots	9	1, 2, 3, 5, 6, 9, 10, 11, 13
Kinds of roots	4	1, 3, 9, 10
Structures of roots	6	1, 3, 6, 9, 10, 11

Functions of roots	9	1, 2, 3, 5, 6, 9, 10, 11, 13
Relation of soil to roots	4	1, 3, 9, 10
Effect of outside stimuli	2	10, 13
Starch in roots	2	3, 10
Relationship of roots to other organisms	1	3
Economic value of roots	2	1, 10
25. Stems	8	1, 3, 5, 6, 9, 10, 11, 13
Ecological responses of stems	1	9
Kinds of stems	3	1, 3, 9
Structure of a stem	8	1, 3, 5, 6, 9, 10, 11, 13
Function of the stem	7	1, 3, 6, 9, 10, 11, 13
Relation of stem to rest of plant	1	9
Useful stems	2	1, 3
26. Leaves and food making	9	1, 3, 5, 6, 7, 9, 10, 11, 13
Types of leaves	5	1, 3, 5, 9, 13
Arrangement of leaves	2	1, 10
Structure of leaves	7	1, 3, 5, 9, 10, 11, 13
Function of leaves	9	1, 3, 5, 6, 7, 9, 10, 11, 13
Photosynthesis	9	1, 3, 4, 5, 6, 7, 9, 10, 13
Food storage	1	3
Transpiration	4	3, 5, 7, 10
Adaptations of leaves	2	1, 3
Loss of leaves in winter	2	1, 13
Relation of leaves to roots and stems	1	9
Man's dependency upon chlorophyll	1	3
27. Flowers	9	1, 3, 4, 5, 6, 9, 10, 11, 13
Types of flowers	6	1, 3, 9, 10, 11, 13
Parts of a flower	7	1, 3, 4, 9, 10, 11, 13
Pollination	6	1, 3, 6, 9, 10, 11
Fertilization of flowers	5	1, 3, 4, 6, 10
Division of labor in the flower plant	1	1
Interesting flowers	1	9
Autumn flowers	2	5, 9
Methods of mounting and preserving specimens	1	5
28. Fruits and seeds	10	1, 3, 4, 5, 6, 7, 9, 10, 11, 13
Reproduction in plants	8	4, 5, 6, 7, 9, 10, 11, 13
Definition of a fruit	3	1, 3, 10
Part of flower to become fruit	3	1, 3, 6
Types of fruit	3	1, 3, 9
Plants that never have fruits	1	3
Definition of a seed	2	1, 6
Parts of the seed	6	1, 3, 4, 6, 11, 13
Function of seed parts	3	1, 3, 5
Seeds plants	1	11
29. Economic importance of plants	6	1, 3, 7, 9, 11, 13
Plants and air supply	1	7
Economic uses of roots	3	3, 9, 13
Uses of stems	2	3, 9
Food value of leaves	3	3, 9, 13
Importance of seeds	1	1
Farm crops	3	3, 9, 13
Stored foods in plants	3	1, 7, 9
Dangerous plants	1	5

30. Study of weeds	2	1, 9
31. Differences between green plants and animals	5	1, 4, 7, 10, 13
Similarity of life processes	1	7
Means of protection	2	4, 7
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Movement	2	4, 7
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V. FORESTRY

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33. Kinds of trees	2	1, 13
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Conifer trees	1	13
Deciduous trees	1	13
34. Trees for parks and streets	2	1, 10
35. Economic importance of trees	5	1, 3, 6, 10, 13
Uses of lumber	2	3, 10
Trees and soil	2	3, 10
Value of forests	1	6
Trees and animal life	1	3
Products of the forest	1	3
36. Enemies of trees	4	1, 3, 10, 13
Fire	1	10
Insects	1	10
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Careless lumbering	2	10, 13
37. Forestry problems	8	1, 3, 5, 6, 7, 9, 10, 13
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VI. ANIMALS

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Digestion	5	6, 7, 10, 11, 12
Absorption and assimilation	8	2, 4, 6, 7, 8, 13
Respiration	4	6, 7, 10, 12
Circulation	5	4, 6, 7, 10, 12
Excretion	5	6, 7, 10, 11, 12
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39. Protozoa	8	1, 2, 3, 4, 6, 10, 11, 12
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Half plant and half animal forms	3	1, 4, 12
Economic importance	1	4
40. Porifera	4	2, 6, 7, 12
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Study of sponges	2	2, 6
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41. Coelenterata	5	1, 2, 6, 11, 12
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Corals	3	2, 6, 12
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Jellyfish	2	6, 11
42. Round and flat worms	5	1, 2, 6, 11, 12
Life histories	2	1, 6
43. Echinoderms	3	2, 6, 11
Starfish	3	2, 6, 11
Economic importance of starfish	1	6
44. Anelid Worms (earthworm)	5	1, 2, 3, 6, 12
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45. Mollusks	4	2, 6, 11, 12
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46. Arthropods	10	1, 2, 3, 4, 5, 6, 10, 11, 12, 13
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Butterflies and moths	2	1, 10
Flies and mosquitoes	2	1, 4
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Insect superiority (numerically)	2	12, 13
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47. Vertebrates	10	1, 2, 3, 6, 7, 8, 10, 11, 12, 13
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The frog	3	1, 3, 10
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Mammals	5	1, 2, 6, 11, 13
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Useful mammals and their protection	1	1
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48. Importance of animals	4	1, 3, 7, 10
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VII. THE HUMAN BODY

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50. The digestive system	8	1, 2, 3, 6, 7, 8, 10, 13
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Products of digestion	2	6, 13
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51. Respiration	10	1, 2, 3, 5, 6, 7, 8, 10, 12, 13
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52. Circulation	8	1, 2, 3, 6, 7, 8, 12, 13
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53. Excretion	8	1, 2, 3, 6, 7, 8, 10, 13
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55. The nervous system	9	1, 2, 3, 6, 7, 8, 10, 12, 13
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Nervous control and habits	7	1, 2, 3, 6, 8, 10, 12
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56. Reproduction	6	2, 4, 6, 7, 8, 10
The reproductive system	4	6, 7, 8, 10
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57. Teeth and their care	5	1, 3, 7, 10, 13
58. Sensory organs	6	1, 3, 7, 10, 11, 12
Structure and use of the eye	3	1, 3, 10
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59. Bodily health	10	1, 2, 3, 4, 5, 6, 7, 8, 10, 11
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61. Green plants as source of all food	1	13
62. Uses of food in organisms	6	1, 3, 5, 7, 8, 11
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63. A balanced diet	8	1, 3, 6, 7, 8, 10, 11, 13
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64. Vitamins	2	3, 7

65. Calories in the diet	3	7, 10, 13
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Fuel value of foods	2	7, 10
Heat of body	1	7
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66. Food tests	2	3, 5
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Sugar test	2	3, 5
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67. Food economy	4	1, 3, 7, 10
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Wastefulness of Americans	2	1, 7
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69. Stimulants, narcotics, and food adulteration	5	3, 5, 7, 10, 11
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Tea, coffee and cocoa	1	3
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71. Food cycles	5	2, 4, 6, 7, 11
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72. Nitrogen fixing bacteria (see useful bacteria)		
73. Colonial life in animals	1	6
74. Parasitism and Symbiosis	4	4, 6, 12, 13
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Diseases caused by parasites	1	12
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75. Predacious plants and animals	1	4
76. Life and the destruction of other living things (control)	3	1, 4, 5
77. Reaction of an organism to its environment	1	4
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X. BEHAVIOR OF LIVING THINGS

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81. Reflex actions, instincts, and habits	3	4, 5, 11
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82. Mechanical behavior	3	4, 5, 11
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83. Chance behavior	1	5
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85. Bird and insect behaviorism	2	4, 12
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88. Heredity	10	1, 2, 3, 4, 5, 6, 7, 8, 10, **13**
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Race modification	2	7, 8
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89. Plant and animal breeding	11	1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13
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XII. MISCELLANEOUS TOPICS

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95. On the trail with rod, camera and gun	2	4, 5
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EASY METHOD OF EXHIBITING INTERFERENCE FRINGES WITH ORDINARY HIGH SCHOOL APPARATUS

By A. V. Pershing
Bloomington, Indiana

The following method gives large, bright fringes. Place a large strip of black paper or black cloth on a table. Obtain an ordinary set of adhesion plates from a Scientific Company. With the ground surfaces together place it close to the edge of the table. Lean a large glass plate over it at an angle of about 50° so that its center is nearly above the adhesion plates. Place weights at edge of glass plate to keep it from slipping. Remove the projector from a Hartl Optical Disc and placing it parallel to table fix it about 14 cm. from where its light will fall upon the glass plate when it is approximately 19 cm. above the table. About 7.5 cm. behind it fix a freshly soaked pad of asbestos which has absorbed much salt from a saturated salt solution. Heat pad with a bunsen burner.

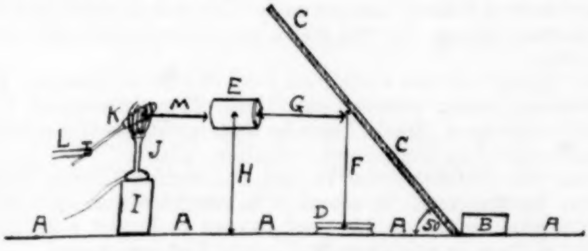

Fig. 1. Apparatus for exhibiting interference fringes.

A. Black paper or black cloth base.
B. Weight to keep glass plate from slipping.
C. Glass plate (ordinary window glass will do); about 30 cm. in length, and making an angle of about 50° with base.
D. Set of ordinary adhesion plates.
E. Projector from an ordinary Hartl optical disc.
F. and H. A distance of 19 cm. approximately.
G. A distance of 14 cm. approximately.
I. Block.
J. Bunsen burner.
K. and L. Salt pad and holder.
M. A distance of 7.5 cm. approximately.

Support for projector not shown.
Heavy posts may be used to lean glass plate over on, one post at either side.

If the adjustment is not too clumsy the fringes will be produced the first time attempted and quite easily. The fringes are so large and bright that they may be seen in daylight even.

Arranging the apparatus carefully I have obtained fringes in broad daylight. Even turning on the electric lights did not cause them to vanish.

The observer may merely walk up to the table and lean slightly over to view them. By pressing the upper adhesion plate with the hands the fringes change rapidly. Greater change takes place if the upper plate is rotated upon the lower one. The fringes are never lost by tampering with the plates, as long as they are in contact.

"GIANT" OXYGEN MOLECULES FOUND TWICE NORMAL SIZE

The existence of oxygen molecules twice as large as those found in the gaseous oxygen of the earth's atmosphere has been proved in experiments announced jointly from the physical chemistry laboratories of Cambridge University and the University of Berlin's Physical Chemistry Institute by Dr. H. Salow and Dr. W. Steiner.

The new kind of "giant" oxygen molecules each contain four atoms of oxygen. Normal oxygen like that which man breathes has only two atoms in its makeup.

Oxygen "giants" are not a common form of atomic existence. Few ever occur, probably, under average conditions. They correspond in atomic circles to the side-show "freaks" seen by man in circuses; for special sets of circumstances produce both circus and atom "giants."

What are the circumstances? In man the malfunctioning of the body glands may be the cause; in atoms it is overcrowding. Drs. Salow and Steiner can produce the double-sized oxygen molecules only when they pack many of them in containers and create high pressures.

The new discovery is reported to the British science journal, *Nature*.

THE UNITED STATES COAST AND GEODETIC SURVEY*

Its Works and Problems

By Helen M. Strong

Department of Commerce, Washington, D.C.

The Coast and Geodetic Survey, the oldest scientific Bureau in the Government, charts the coastal waters of the United States and its possessions, and establishes exact locations and elevations on land. This means going into the field and, at first hand, with instruments and equipment, surveying a land area as large as all Europe and South Africa put together, and coastal waters extending for thousands of miles.

The safety of every ship which enters an American harbor from Alaska to the Caribbean, from the Philippines to Puerto Rico, depends upon the Coast and Geodetic Survey. On land, engineers for all surveying operations and many kinds of construction work rely upon the geodetic control established by this same survey.

Like all fundamental work, it goes on so quietly as to be almost unrealized. Recently many of us have inspected the wonderful new trains such as the "Zephyr," but none, or at least only very few of us, have known about the months and years that were spent in scientific research preparing for construction of these swift moving transportation units. So it is with the engineering and scientific work of the Coast and Geodetic Survey.

Some of you have seen those fascinating old maps and charts. Shapes on them are strange, distances between places are not at all as we know them to be, capes and islands are frequently far from their true locations, all because control surveys were lacking.

Modern maps and charts of the same areas present a different picture, because places on them are located by exact geodetic surveys, and all the other data of roads, mountains, and streams; soundings, shoreline, rocks and shoals, have been placed with reference to these precisely obtained positions.

Geodetic control surveys lay the foundation for the topographic survey on land, and the hydrographic survey on water,

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* Read July 5, 1934, before Science Department of the National Educational Association, Washington, D.C.

which provide the source material out of which maps and charts are made. These surveys are the field work which, by means of triangulation, establishes exact locations and elevations, and provides the basic framework of all maps. Upon this the cartographer may lay down his state or county boundaries, rivers, and lakes. The topographer may in turn go into the field, and on it locate his contours for mountain, valley and plain; his roads, railroads, and houses; his streams and coastlines. Flood control engineers will use the basic geodetic survey to aid in locating reservoirs and dams, drainage and conservancy areas. Hydrographers will tie into triangulation stations along the coast so as to place precisely their lines of soundings, sunken rocks and rocks awash, and thus accurately develop the depth curves of the sea bottom, providing the data for navigation charts.

Geodetic surveys first were made in widely separated areas,—some on the Atlantic Coast, some in the Middle West, and others along the Pacific Coast. Gradually these areas merged, and a line of precise triangulation was carried across the country along the 39th parallel. Later other lines were extended north-and-south and east-and-west.

As soon as continuous areas of triangulation, or in other words lines of exact positions, extended from the Atlantic to the Pacific, and the Canadian Border to the Gulf, location of all places in the United States could be related to a common reference point,—Meades Ranch in central Kansas. Canada and Mexico then united with the United States in referring all their locations to this same place, and thus the "United States Datum" became the "North American Datum."

Some day a line of precise triangulation may cross Central America and Panama into South America, and no longer will there be a "North American Datum," but instead an "American Datum."

The carrying on of this survey is filled with stories of heroism and self-sacrificing devotion.

When the "Forty-niners," in their rush for gold overnight changed San Francisco Bay from a harbor far out on the edge of human interest, to the focal point toward which ships headed from all parts of the world, no control surveys had been made along the Pacific Coast.

In 1848, immediately following discovery of gold at Sutter's Mill, the government realized that control surveys were impera-

tive in California. They sent out engineers who were to hire hands from local San Francisco labor. But men would not take these survey jobs. A mere forty or fifty dollars a month of government pay held no attraction, when they could make hundreds of dollars staking a claim, or earn $10 or $12 a day working in the city or the gold diggings.

In this emergency four of the younger officers of the Coast Survey, stationed in its Washington offices, volunteered to go to the Pacific Coast and undertake "for one year to do any duty however hard or manual," at their regular rate of pay, $60 a month. So the survey was accomplished. One of these young men, George Davidson, stayed in California, where he eventually was in charge of the San Francisco office of the Coast Survey. With tireless energy he explored and surveyed from California to Alaska, and gave us the first Coast Pilot of these waters.

For the California coastal waters, practically no charts were available in 1849, except those of the early explorers which frequently were on too small a scale, or too sketchy and inaccurate to be of real value. Shore features on some of these charts were off their true position as much as fifty miles. Shoals and shallows, hidden rocks and dangerous cross currents were incorrectly located or not shown at all. Impenetrable fog at times blanketed the sea and blotted out breakers or kelp or dangerous headlands. San Francisco harbor had not been carefully surveyed. During the nine months ending December 31, 1849, seven hundred trading vessels arrived there, as many as 65 coming in one day. Anchorage and dock space were at a premium. During this year 39,000 people arrived in California by sea. Manifestly this situation in which thousands of lives were endangered for lack of navigation charts, called for action. Two officers of the Coast Survey, Lieut. Commanding William P. McArthur and Lieut. Washington A. Bartlett, were sent out from Washington to survey the coastal waters from Monterey to the Columbia River, and select sites for lighthouses. Arriving on the coast they encountered almost insurmountable obstacles. Sailors and other hands were obtained with utmost difficulty, because government wages of one or two dollars a day held no attraction. Finally the crew was completed and the survey of the coast went forward. Charts and sailing directions were prepared so that ships could navigate there in safety. The labors of these two years so sapped the strength of Lieut. McArthur,

that he succumbed to a tropical illness on the way home, and never again saw his wife and children.

Methods and equipment for surveying on land and sea have changed materially since the early work on the Atlantic and Pacific Coasts. In place of the sailing ship and the hand-lead is the steam vessel which carries modern scientific instruments, more than one of which was developed by Coast Survey engineers. Among these are the fathometer, the wire drag, and radio acoustic range finding equipment. The first enables the surveyor to cover thoroughly the ocean bottom without stopping the ship, whereas with a hand-lead and sailing vessel, the ship had to be stopped while several hundred feet of line were paid out and hauled in again. This consumed so much time, that soundings necessarily were spaced at long intervals. Several hours might be required to make but one sounding in deep water.

Scattered soundings may leave dangers such as pinnacle rocks uncharted. Many of these exist in Alaskan waters, in some cases on main steamer channels. These slender rock spires in many cases extend from smooth deep bottom to within a few feet of the surface. They have wrecked many a good craft, before the Coast Survey went into Alaskan waters. Now these areas are literally combed with the fathometer and the wire drag. A pinnacle may escape the fathometer, but it cannot avoid the wire drag which catches on the slightest obstruction.

While surveying in Alaskan waters the Coast Survey vessels are often called upon to render aid to ships in distress. In 1927, the Coast Survey ship "Explorer," working in southeastern Alaska, picked up the calls of the "Princess Charlotte," aground on a reef near the town of Wrangell. Although it was night and the "Explorer" was anchored in a bay full of rocks with no lights on them, she succeeded in getting out through the fog, reached the scene of the wreck and took off the passengers.

Corsair Gorge—a deep valley two miles wide, eight miles long, and 1800 feet deep; another gorge 11 miles long, over 2 miles wide, and about 2000 feet deep—magnificent valleys, but you may never see them unless you don a diver's helmet. For eighty years, from time to time, careful hand-lead soundings have been run over Georges Bank, the great tumbled mass of huge boulders and glacial debris that was dumped in the ocean east of Cape Cod by the continental ice sheet. It remained for the electric ear of the fathometer, running continu-

ous lines of soundings, to discover these great submarine valleys directly on the route of trans-Atlantic steamers.

Most of these steamers carry echo sounding instruments which reveal the contour of the ocean bottom, just as the human eye sees the terrain over which an airplane is being piloted. In this stormy fog-beset area of strong tide rips there never has been any visible aid to navigation. The charting of these two gorges enables the navigator to locate his ship with reference to the dangerous Cape Cod and Nantucket Shoals, even in a fog. Similar surveys are being made on other dangerous areas in American coastal waters, rendering them safe for the thousands of ships which sail over them.

Fog occurs so frequently off some coasts as to interfere seriously with survey work, when sights are taken to three known points on the shore, a "three point fix," in order to establish the position of the soundings. When fog blots out the shore, soundings cannot be located by this method and work perforce ceases.

With development of radio acoustic range finding apparatus, even in a fog, a survey ship may locate itself and go forward with its work of sounding. The method used is briefly this. Small bombs are exploded by the survey ship. Hydrophones have been placed at established locations on the shore. These receive the explosions and relay the times of explosion to the survey ship by characteristic radio signals. Thus the survey ship obtains a fix by sound instead of sight and locates its position. On fog-ridden coasts the work of sounding has been known to go forward without interruption, even when the bow sprit is invisible from the bridge. This device has proven invaluable on the north Pacific coast and off New England.

Changing coast lines necessitate new surveys. Whenever you read of a great storm sweeping the Gulf of Mexico, the "graveyard of ships" off Cape Hatteras, the shifting shoals of Peaked Hill Bar and Monomoy off Cape Cod, or that ever moving long line of barrier reefs and sand spits fringing the seaboard from Long Island to Cape Sable and thence around the Gulf of Mexico to the mouth of the Rio Grande, you may know that Coast Survey parties soon will be in those waters, resurveying the changed bottom and shore line, so that ships may sail safely, for the forces of nature have decreed that constant surveying is the price of safe navigation.

In Alaska and on some of the islands the waters yet await

careful exploration. Larger vessels of deeper draught and high speed require more detailed charts than the old slower-moving and smaller sailing vessel, so that new surveys must replace old. Reconnaissance work in other places must give way to modern surveys.

So vast is this task of charting the coastal waters and running survey lines over the land, that the Coast and Geodetic Survey faces a great responsibility for the life and safety of those of the future who go down to the sea in ships, and for the well-being of the millions who earn their livelihood or seek their pleasure on the land. As in the days of the "Forty-niners," its engineers will continue to carry on their work with scientific accuracy and whole hearted devotion.

HOW TO STUDY ARITHMETIC*

By Margaret R. Walters
Los Angeles, California

Under the present school conditions, children are not studying arithmetic to the best advantage due to the fact that teachers are not offering them specific study helps. Time is being wasted in the study of arithmetic because children are not receiving a good foundation for further work, and too much time is now being spent on learning this subject. This investigation is an attempt to gather study methods and devices to aid the child in his study of arithmetic.

The method of procedure followed was suggested by Dr. C. C. Crawford and is of the "job analysis" type. The first step was to discover as many as possible of the difficulties encountered in the study of arithmetic; these were collected from discussions with teachers and students, discussion with business men, printed material on the subject, and personal observation. The difficulties were sorted and re-sorted and finally arranged in topics which this investigation has attempted to solve.

Thirty teachers of the Los Angeles City Schools and schools of neighboring cities were interviewed. Each person was asked specific questions based on the main topics. Notes were taken throughout the interviews and later re-organized under the topic to which they fitted. To this was added all other material acquired from printed matter, other interviews, and observation.

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* Summary of a Master's thesis, University of Southern California, June 1933.

No attempt has been made to evaluate these devices although some attempt has been made to bring out the values or limitations of some of them. All suggestions related to the subject of the investigation are included here. The following outline is based on the difficulties encountered in studying arithmetic and offers suggestions to solve them. It is a brief summary of the results of the investigation.

I. How to learn the terminology of arithmetic
  1. How to learn the definition of arithmetical terms
    1. Study the definition of the term
    2. Draw a picture of the term
    3. Use a measure to learn lengths and units of measure
    4. Handle the object to which the term refers
    5. Cut pictures of the term out of paper
    6. Watch for evidences of the term in nature
    7. Do what the term refers to
    8. Compare the term with some similar thing
    9. Use rhymes or memory devices
    10. Test yourself to see if you can give the definition of a term
  2. How to learn arithmetical concepts
    1. Use your definition of the term as a basis
    2. Extend your idea to different cases
    3. Draw pictures of different instances
    4. Look for instances in nature and life
    5. Compare the concept with similar things
    6. Consider what your concept is, not what it is not
    7. See that your knowledge of each concept is complete

II. How to learn the fundamental processes
  1. How to learn the fundamentals most economically
    1. Learn the meanings of the signs and terms
    2. Verify what you are doing before memorizing combinations
    3. Do not guess at combinations
    4. Do not count on your fingers
    5. Drill on one element at a time
    6. Memorize number facts in groups
    7. Learn the combinations by writing, saying, seeing them
    8. Learn addition and multiplication combinations in the usual and reverse forms
    9. Learn the zero combinations last
  2. How to learn addition and subtraction
    1. Count by 2's, 3's, 4's
    2. Make combinations with objects
    3. Translate the combinations made from objects into figures
    4. Use a number scale for drill
    5. Memorize combinations, fold your paper over the answers, and then do the problems
    6. Use a bar form for drill on the fundamentals
    7. When carrying or borrowing, consider the numbers as money
    8. Add the carried number first
    9. Recognize the constant ending when adding one number to any other with a constant ending.

3. How to learn multiplication and division
   1. Understand what multiplication and division are before memorizing the combinations
   2. Learn the ten tables first
   3. Study the combinations involved in problems
   4. Break the problem or process into parts
   5. Make an outline of the necessary things to do
   6. Practice where to place the quotient figure
   7. Estimate and check quotient figure before doing further work
   8. Watch zero carefully

III. How to study fractions and decimals
1. How to acquire the concept of a fraction
   1. Divide a whole thing into equal parts
   2. Compare fractions to determine equivalence
   3. Divide a whole into two different fractional units and compare these
   4. Practice estimating the relative size of fractions
   5. Compare a fraction of one thing with a fraction of another
   6. Drill on value is 1 when numerator and denominator are equal
   7. Memorize decimal values of fractions
2. How to learn the fundamentals as applied to fractions
   1. Memorize the rules for handling fractions
   2. Perform reductions before doing operations
   3. Have least common denominator before adding or subtracting
   4. Make amount borrowed part of the fraction
   5. Change mixed numbers to improper fractions before multiplying or dividing
   6. Watch for possibilities of cancellation
   7. Review tables
3. How to learn the fundamentals applied to decimals
   1. Learn the value of a decimal through comparison
   2. Learn to read and write decimals
   3. Learn the rules for placing the decimal point
   4. Consider the fundamentals the same as whole numbers
   5. Relate decimals to our money system
   6. Consider percentage as a decimal form

IV. How to study mensuration
1. How to study the geometric figures used in arithmetic
   1. Look around for examples of the figures
   2. Make cardboard figures
   3. Differentiate between one and two dimensional things
   4. Memorize the units of measure
   5. Relate an angle to the hands of a clock
   6. Find the value of π yourself
   7. Study geometric figures by comparing their perimeters, areas, and angles
   8. Make a table of the outstanding characteristics of the geometric figures
   9. Prove the area of a circle is $\pi r^2/2$
2. How to use geometric figures as an aid to doing problems
   1. Make your drawings exact

2. Make figure a general case unless otherwise specified
3. Make figures large enough to be clear
4. Use "height" instead of "altitude"
5. Mark off on the figure the parts known
6. Write the necessary formula and make substitutions
7. Practice interpreting graphs
8. Have definite method of constructing a line graph

V. How to do arithmetic problems

1. How to read the problem
    1. Understand the words in the problem
    2. Read over the problem disregarding the figures
    3. Re-state the problem in your own words
    4. Turn the words of the problem into symbols
    5. Note what is given and desired; re-read the problem
    6. Read each problem at least twice
    7. Read the problem aloud
    8. Be sure you understand the problem before going on with it
2. How to work toward a solution
    1. Begin your analysis with questions
    2. Let the teacher's method of attacking similar problems help you
    3. Try verbal analysis
    4. Refer to similar problems
    5. Look through the formulas already studied
    6. Draw a picture of what you have
    7. Refer the problem to actual happenings
    8. Make a mental review of methods used in similar relationships
    9. Review previous work in the text
    10. Study analysis of problems as developed in the text
    11. Review previous work in the fundamentals

VI. How to check arithmetic work

1. How to check the problem
    1. Be sure the problem is copied correctly
    2. See that you answer what the problem asks
    3. See that your answer is logical
    4. Approximate your answers
    5. Consider the answer as given and work for one of the given quantities
    6. Use another method of solution
    7. Use short-cut methods
    8. Draw a picture of your answer
    9. Check the computation
2. How to check the computation in a problem
    1. Check addition by reversing the direction of the process
    2. Check addition by adding total columns by parts
    3. Check addition with a column check
    4. Check addition by adding the columns without carrying
    5. Check subtraction by adding the difference and subtrahend
    6. Check subtraction by subtracting the result from the minuend
    7. Check multiplication by interchanging multiplier and multiplicand

8. Check multiplication by multiplying by parts
9. Check multiplication by division and vice versa
10. Check division by checking the internal parts

VII. How to acquire accuracy and speed
1. How to acquire accuracy
    1. Make a habit of checking
    2. Write neatly
    3. Copy figures accurately
    4. Determine what you need to concentrate on particularly
    5. Think briefly and clearly
    6. Know the fundamentals
    7. Understand how to compute with zero
    8. Analyze your errors and don't make them again
2. How to acquire speed
    1. Be accurate
    2. Get rid of all crutches
    3. Drill until the fundamentals are automatic
    4. Do not write more than is necessary
    5. Watch for opportunities to cancel
    6. Use the simplest operations possible
    7. Be aware of cutting down time
    8. Use short-cuts

VIII. How to use labor saving devices
1. How to use labor saving devices
    1. Learn the long method first
    2. Make labor saving devices automatic
    3. Use a labor saving device and its long method alternately
    4. Use labor saving devices in problems whenever possible
    5. Solve old problems by the newest methods
    6. Avoid elaborate short cuts
    7. Diagnose the situation and determine whether to use a labor saving device or not
    8. Make your own short cuts
    9. Learn a few combinations and equalities which you commonly use
2. What labor saving devices to use
    1. Add and subtract by tens
    2. Add fractions with the same numerator by adding denominators
    3. Multiply by 9 by multiplying by 10 and subtracting the multiplicand
    4. Multiply by 11 by adding the figures of the multiplicand
    5. Multiply by 5 by moving the decimal point one place to the right and dividing by 2
    6. Multiply and divide by a fraction of 100 by moving the decimal point two places to the right or left respectively and dividing the product by the denominator of the fraction
    7. Test a number before attempting to divide it evenly by 2, 3, 4, 5, 9, 10
    8. In long division make use of previous products used in the same problem
    9. When dividing by 17, 18, 19, consider the divisor as 20 to discover the quotient figure

REMEDIAL CLASSES IN GEOMETRY

By Joseph A. Nyberg
Hyde Park High School, Chicago

What can be done to help the slow, backward, and dull pupils in geometry? In the Hyde Park High School classes in "remedial" geometry were organized for such pupils, and this paper presents my experiences with such a class.

The class met during the seventh period. Any teacher who felt that a pupil needed help on some particular topic or who regularly needed help to master the daily work could recommend that the pupil attend the class. The pupil is advised to attend until he has overcome his particular difficulty, but he may continue as long as he chooses. Due to the crowded condition of the school the class met in the lunchroom and all instruction was done by the individual method. The pupil would begin working on any task he chose, and I would walk from table to table giving such help and advice as the pupil seemed to need.

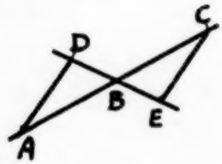
As is always the case with individual instruction, I frequently had to ask each pupil almost the same questions. For example, how do you prove triangles congruent? When the superposition proofs have been discussed in class, the tendency of the pupil is to use superposition in his exercises. This is only natural because in algebra the exercises are solved in the same manner as the examples in the text, whereas in geometry an exercise is solved by using a theorem and not by using the method that proves the theorem. For this reason some teachers like to adopt the congruence theorems as axioms. This method, however, merely postpones the trouble. The difficulty is not with superposition itself but with the fact that the pupil is beginning geometry, that there always must be a *first* theorem, there always must be a *first* exercise, and there must always be a *first* explanation of how a general statement is applied to a particular situation. A much easier way out of the difficulty is to let the pupil continue to use superposition until he tires of it, until he can see that it is a waste of time to repeat certain statements, and then he will discover how to *use* a general statement. In the remedial class, however, only remedies that act quickly can be used.

Judging solely by the nature of the replies to my questions,

HOW A THEOREM IS USED

Given: AC and DE intersect at B; $DB = BE$, and $AB = BC$.

Prove: $\triangle ABD \cong \triangle BEC$.



1.	$AB = BC$	By hyp.
2.	$\angle ABD = \angle EBC$	Vert. $\measuredangle$s are =.
3.	$DB = BE$	By hyp.

There are 3 important steps. They say that

AB	in	$\triangle ABD$	equals	BC	in	$\triangle BEC$
$\angle ABD$	in	$\triangle ABD$	equals	$\angle EBC$	in	$\triangle BEC$
DB	in	$\triangle ABD$	equals	BE	in	$\triangle BEC$

We could now place $\triangle ABD$ on $\triangle EBC$ as we did in Th. 1.

We could! But why bother to do so? All that work is unnecessary. Having done that work *once,* we know that we can do it again. So, why do it? We merely say "In the same way as in Th. 1 we could now prove these triangles are congruent."

In all future exercises, whenever we find that

a side in one $\triangle$	equals	a side in the other $\triangle$
another side in the first $\triangle$	equals	another side in the second $\triangle$
the angle between these sides in the first $\triangle$	equals	the angle between these sides in the second $\triangle$

we shall say at once

These Triangles Are Congruent

To prove two triangles are congruent, we shall hereafter not bother to place one triangle on the other. We shall merely study the given information (the hypothesis) to see if

3 certain parts of one triangle equal 3 certain parts of the other triangle.

Please help us find 3 parts of one triangle equal to 3 parts in the other triangle. 3. Three. THREE. THREE.

Not *any* three; but three: side, angle, side
angle, side, angle
side, side, side.

3 3 3 3 3 3 3 3 3 3 3

the teachers at Hyde Park, including myself, are a very poor lot. They never explain a theorem, they never explain how a theorem is used, they never prove a theorem, they never work an exercise in class—a very poor lot. Judging from other evidence we know that a pupil is an unreliable witness as to what happens in a classroom. The pupil who is assigned to a remedial class does not pay attention to the work done in his regular class. When an explanation is given of how a theorem is used, the dull pupil is thinking about some basket ball game, the latest movie, or how he is going to bluff his history teacher. Hence I spent much time teaching what could have been learned in class. Often, in answer to some question, I could tell the pupil to read a certain paragraph in the text. But the day-dreamers do not like to read.

I finally decided to rewrite some of the most important ideas in language that these pupils could grasp. The wording must be very simple. The sentences must be short. The explanations must be unusual so that they would appeal to the heart and the emotions as well as to the brain. Each lesson was typed on a piece of flexible cardboard about five by eight inches. I carried them with me as I went from table to table. As soon as I saw the pupil's difficulty I handed him the particular card he needed. In most cases no other help was necessary.

It is noteworthy that these special lessons do not contain anything unusual, or anything different from what the pupil could hear in his class if he would but listen. Evidently the difficult part of teaching consists in getting the pupil to pay attention. When dealing with a bright class, it is sufficient to say, for example, that a triangle has three sides. When dealing with a dull class, the teacher needs to say "A triangle has *three* sides. Did I say *two* sides? No! I said *three* sides, t, h, r, e, e. Am I talking about a square? No. I am talking about a triangle. How many sides has a triangle? Three. Can it have four sides? No. Some people think a triangle has two sides, an inside and an outside. But that's the wrong idea of a side. A triangle is made by three lines. Each line is counted as one side. Hence a triangle has three sides." Whereupon Johnny will speak up and say "Oh! I see now. A triangle has three sides. Why didn't you say that in the beginning?"

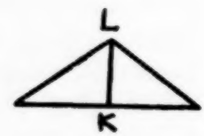
These lessons merely state the same things that any experienced teacher emphasizes every day in class. But, judging from the pupil's remarks about them, they contain new and

SECRET INFORMATION FROM OPERATOR XYZ

How Information Is Disguised Or Cancealed

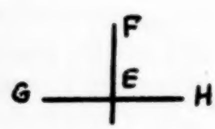
To prove two triangles are congruent we must find 3 certain parts of one triangle that are equal to 3 certain parts in the other triangle. You would hardly expect that the hypothesis would tell you *exactly* which parts are equal. That would make the exercise too easy. The information is disguised, concealed! Let us unravel the disguise. Examine the villain! Ah!

You wouldn't expect the hypothesis to say that KL is a side of both triangles. It is! $KL=KL$ is one of the three equations.

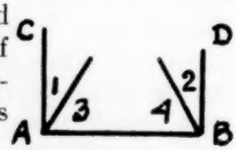


Saying that AC bisects $\angle BAD$ is just a clever way of letting you find out that $\angle BAC = \angle CAD$.

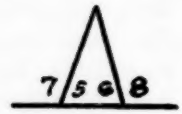
If the hyp. says $EF \perp GH$ you can say $\angle GEF = \angle HEF$. *Perpendicular* makes you think of right angles, and we know that all right angles are equal.



Here's another clever one. If $AC \perp AB$ and $BD \perp AB$, then $\angle BAC = \angle ABD$. And if $\angle 1 = \angle 2$, then $\angle 3 = \angle 4$ because complements of equal angles are equal. Complements are often used to conceal information.



Supplements are also used to make an exercise seem hard. If $\angle 5 = \angle 6$, then $\angle 7 = \angle 8$. Easy, isn't it?



Now you think of a few clever disguises.

A prize of a million genuine pre-war Russian rubles given away for clever disguises.

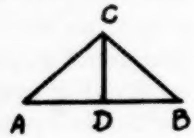
To unravel a disguise you must know your definitions, axioms, and theorems. Well, why don't you learn them?

startling ideas. I was not greatly surprised at the ease with which most of the pupils could do their daily work. Although I have no statistical evidence to support the view, I believe that more pupils fail from lack of trying than from lack of ability. The psychologist is always recommending easier courses for the dull pupils. This assumes that the pupil fails from lack of ability. Too often it is merely lack of interest. What the pupil needs is not an easier course in geometry (which he would also neglect) but more courses in woodwork, foundry, and machine shops. School administrators know this, and also know it is less expensive to organize a class in geometry than to equip a shop. In such a situation the teacher is helpless and can merely try to create an interest in geometry. But we ought to admit frankly that, when giving easy courses, we are doing something from necessity that should not be done at all.

In the attempt to avoid helping the pupil too much, I tried to prepare him for a particular exercise by suggesting some easier ones which would gradually lead him onward. But the easy exercises in which $A=40$ and $B=40$ did not help the pupil to see that certain angles were equal because they were vertical angles, or that certain angles were equal because they were right angles. Some gradation of exercises is essential but the idea has been overworked. Many years ago we used to subdivide factoring into a dozen cases; now we have too many subdivisions for congruent triangles. After the pupil had read the lesson about disguising information, he could see that the easy exercises merely hinted at those ideas which this lesson stated boldly. As one pupil stated, "It's just a game to see how you can say one thing when you mean something else." This statement is a fairly good summary of any deductive science. Playing bridge we say "one spade" when we really mean that we hold certain cards. We say a triangle is isosceles when we really mean that it has two equal angles. I took advantage of the pupil's remark to explain that his problem will always be to deduce from the given information those facts which are of value at that time. "And how can you tell," he asked, "what he really means when there are several things he might mean?" We decided that we could try each idea until we came to the right one. "That's just more work than I want" concluded one pupil, again showing that it is lack of interest rather than lack of ability which is holding many pupils back.

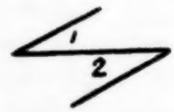
TWO CONGRUENT TRIANGLES WILL DO ALMOST ANYTHING

1. How do you prove two lines, as AD and DB, are equal. Answer: Prove that they are the corresponding parts of two congruent triangles. In short, the answer is



Prove Two Triangles Congruent

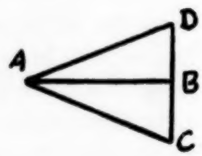
2. How do you prove two angles, as 1 and 2, are equal? Answer:



Prove Two Triangles Congruent.

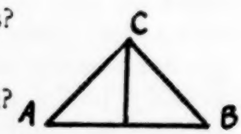
But what would you do if there were no triangles in the figure? Answer: Draw some lines to make some triangles.

3. How do you prove AB bisects $\angle CAD$? Answer: Prove $\angle CAB = \angle BAD$.



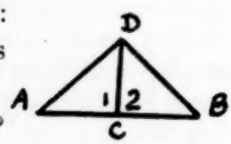
And how do you prove two angles equal? Answer: Prove Two Triangles Congruent.

4. How do you prove $\triangle ACB$ is isosceles? Answer: Prove $AC = BC$.



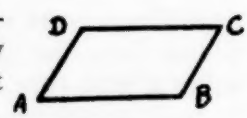
But how do you prove two lines equal? Answer: Prove Two Triangles Congruent.

5. How do you prove $CD \perp AB$? Answer: Prove two supplementary adjacent angles equal, as $\angle 1 = \angle 2$.



But how do you prove two angles equal? Prove Two Triangles congruent.

6. How do you prove $ABCD$ is a parallelogram? Answer: Right now I don't know what a parallelogram is, but I'll bet that you prove two triangles congruent.



7. How do you make a million dollars? Answer: There's no such thing; but the last fellow who did it must have proved two triangles congruent.

Remedial classes suggest a number of other interesting questions of which the chief one is: Do they decrease the number of failures? In the frequent discussions of this question I have never heard a definition of failure. Even teachers of mathematics who boast that mathematics teaches us to reason correctly and to define our terms, neglect this important definition. If a pupil needs instruction two periods a day in which to learn what 80 percent of the pupils can learn in one period, isn't he a failure even if he gets credit for a course in geometry at the end of one year? And if the pupil must be taught elementary arithmetic and compass work and gets credit for such work while other pupils are learning about demonstrative geometry I believe in still calling him a failure. I believe of course that a pupil should be taught whatever he needs to know and is capable of learning, but we need some Pure Food labels on our courses in mathematics as well as on our edibles. I suggest that the word geometry be restricted to those courses in which some real demonstration is done, and that the other courses be designated by some other title like Tenth Grade Mathematics. The title should either be specific and exact or else so vague that it can mislead no one. If *failure* is correctly defined then the remedial classes do not decrease the number of failures.

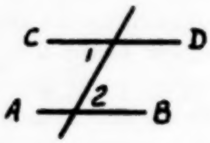
They do not save the tax-payer's money because if I were not teaching this class I could be teaching some other class. The cost to the tax-payer is the same whether a pupil spends two periods a day for one semester or one period a day for two semesters. The same arithmetic, however, will show that the cost is not decreased by omitting remedial classes. Hence we hear the argument that segregation according to abilities is desirable because of the psychological value to the pupil in not being branded a failure. This assumes that when a pupil is put into a remedial class or into a "slow moving" class he is unconscious of the fact that he is not doing as brilliant work as some of his classmates. Evidently if he becomes conscious of this fact then the psychological value is all lost. This theory also assumes that the notions we have held about inferiority complexes are correct. For the past decade there has been a feeling among many teachers that a pupil will develop this thing we call an inferiority complex if the pupil fails in anything, and that therefore he must not be allowed to fail in any undertaking; we should find out what he can do and not hurt his feelings by asking more of him than he cares to do. The

KRAZY KAT AND MICKEY MOUSE HAVE A POLITE ARGUMENT

Said Krazy Kat to Mickey Mouse:

If $\angle 1 = \angle 2$

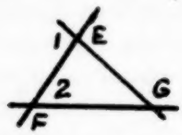
then AB and CD are parallel.



Said Mickey Mouse to Krazy Kat:

$\angle 1$ equals $\angle 2$, but AB and CD are not parallel.

Now Krazy Kat was a very polite cat. He had been raised in the very best alleys, and was always willing to admit that he might be wrong. So he said politely "Let's pretend you are right.



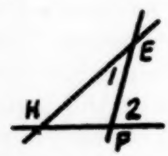
Suppose AB and CD are not parallel.

Then they meet somewhere, at G."

Said Mickey Mouse to Krazy Kat: "That's right. They meet at G."

Said Krazy Kat: "But then, $\angle 1$ is an exterior angle of $\triangle FEG$, and so $\angle 1$ is greater than $\angle 2$. That contradicts your statement that $\angle 1 = \angle 2$."

Said Mickey Mouse: "It was your idea that they meet at G. They meet at some point at the left of FE, as H."



Said Krazy Kat: "Then $\angle 2$ will be an exterior angle of $\triangle HFE$, and so $\angle 2$ will be greater than $\angle 1$. This contradicts your statement that $\angle 1 = \angle 2$. You contradict yourself."

Now Mickey Mouse was just as polite as Krazy Kat, and could see that he would always be contradicting himself unless he admitted that Krazy Kat was right. He admitted that the lines were parallel.

An indirect proof is the politest kind of argument because you begin by supposing that you are wrong and the other fellow is right. After supposing he is right, you must by some clever work make him contradict some statement. Of course, even when you show him up as a prevaricator (look that one up in the dictionary) you should do so politely.

New Era may bring a reaction from this attitude. The reaction is ably expressed by G. A. Parkinson in School Science and Mathematics, October 1933, page 723, one sentence of which is "I believe that it is just as essential to teach students to react properly to failure as it is to teach them to acclimate themselves to success." And I may add that if the pendulum swings far enough in that direction we shall reach a point when one of the requirements for graduation or for college entrance will be "evidence that the pupil has reacted properly toward failure in some work"

No one will deny the existence of inferiority complexes, but they are developed only when the pupil has a feeling of failure in an undertaking that he considers important. The pupils in my remedial class felt that geometry was of little importance, that in all the important undertakings of life they were as brilliant as the rest, in fact more brilliant. It is strange that we hear so little about superiority complexes, or equality complexes. It is time for some one to blame the depression on the fact that the schools were allowing pupils to believe that one man was as good as any other, that one banker was as honest as another, that one bond was as safe as another. What then, shall we do with the dull pupil? To segregate the bright pupil from the dull one in order that the dull ones may not impede the progress of the good ones is certainly a commendable plan. Encourage the dull one to do the best he can, admit that he will make a better carpenter than a lawyer, and insist that a good carpenter is a better citizen and a happier man than a poor lawyer. We will continue teaching the dull pupil whatever he can learn, and in the meantime we can be busy trying to find out what it is that would be most useful to him.

Teachers who are interested in remedial classes should not fail to read Monograph No. 13 of the National Survey of Secondary Education, entitled Provision for Individual Differences, Marking, and Promotion, obtainable for 40 cents from the Office of Education, United States Department of Interior.

Minds stuffed with a smattering of science may be just as opinionated as minds stuffed with a smattering of theology.—*Everett Dean Martin*

DEMONSTRATING CONVECTION CURRENTS

By Otto R. Ariens
Community High School, Mason City, Illinois

It has often been my wish to have a piece of apparatus that would adequately show the movements of air in a heated room, both near the stove or radiator and also at places away from such a heater. All of the simpler pieces of apparatus with which I am familiar make use of smoke arising from a burning or heated source, the heat of which itself sets up convection currents that often are not wanted and spoil the effects it is desired to show. As a result, the apparatus described in this article was made and used in both my physics and general science classes with enough success to make me feel that my efforts were not entirely wasted. It is with the thought that some other classroom teacher may find use for such an apparatus that I am describing it, fully realizing that many teachers will be able to make improvements in it.

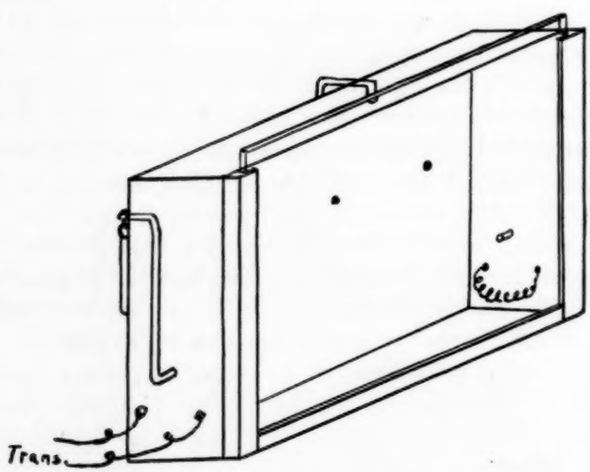


Fig. 1.

The apparatus consists of a shallow wooden box, 20 × 12 × 3 inches in size, painted a dull black inside and equipped with a sliding glass front. By referring to figure 1 the general appearance of the apparatus can be seen. At each end, about 2 inches from the floor, is an electric heater (to take the place of the

radiator in the room) made by coiling a piece of number 22 nichrome wire, about 3 feet long, around a 10-penny nail. This coil is held in place with two stove bolts, extending through the ends of the box, which also provide a means of connecting the heater to the source of electric current. Unless too long a coil is used the wire is stiff enough to hold the coil out at right angles to the ends of the box. Above each heater in the ends of the box, and also in the center of the top, is a small hole through which extends a short glass tube. On the outside, each of these tubes is connected to a smoke generator attached to the rear of the box.

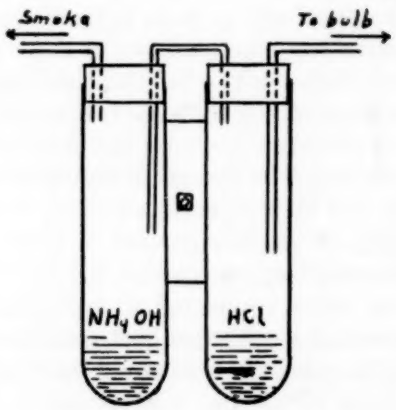


Fig. 2

Reference to figure 2 will show the construction of the smoke generators. Each one consists of two 8 × 1 inch test tubes with two-hole stoppers and glass tubes as shown. For the bulbs I used the rubber bulbs that are employed with that type of dew point apparatus in which a stream of air is forced through ether. The intake valve with which these bulbs are equipped is almost a necessity to prevent drawing air out of the box backward through the generator when the pressure on the bulb is released. Any similar bulb could be used or it might even be dispensed with altogether, the operator gently blowing through the tubing instead of squeezing the bulb. The two test tubes are firmly tied together and supported by a bolt extending through the back of the box. When HCl is placed in one test tube, NH_4OH in the other, and the bulb squeezed, the vapors in the two test tubes are mixed forming the familiar NH_4Cl "smoke" which is forced out

into the box through any one of the three tubes mentioned. In my apparatus I used three separate generators although just one could be used by changing it from one place to another as needed. The added convenience of using three generators will more than compensate for the original trouble of assembling them.

The reason for using NH_4Cl smoke is that it is relatively cool and if it is forced into the box gently no unwanted convection currents are formed. Then also, the amount of smoke and the place it is applied can be easily controlled by squeezing for a longer or shorter time and on any bulb necessary. It is almost essential that the glass front be made so it can be easily removed. After the apparatus has been used two or three minutes the box becomes so filled with smoke that the circulation of the air is indistinct. By simply raising the glass front all of this smoke immediately leaves and after lowering the glass again the demonstration may proceed. The smoke admitted into the classroom soon disappears and in such small amounts is harmless.

For the supply of electric current a small transformer of from 2–20 volts secondary was used in the 110 volt light circuit. The two heaters were connected in parallel, each having a switch in series with it so either or both could be used as desired. Instead of using a transformer it would be quite possible to use several dry cells in series, but I happened to have the transformer available so made use of it. It was found, for the heaters used, that about 4–8 volts gave the best results although this might vary with different sizes of apparatus.

Perhaps one difficulty experienced in the use of the apparatus should be pointed out. That had to do with the glass front acting as a mirror for objects in front of it, thereby making it difficult for some students to see the circulation within the box as well as they should. This was especially true when the light in the room came from behind the box, but after a few trials a position in the classroom was found where these images were reduced to a minimum and the entire class could see satisfactorily. If any other teacher feels that this apparatus is worth trying out and is able to overcome these objectionable reflections I would be glad to hear of it.

The work of science is to substitute facts for appearances and demonstrations for impressions.—*John Ruskin*

WON BY A NOSE

By William R. Winicov

South Philadelphia Boys High School, Philadelphia, Pennsylvania

[The Scott living room on a summer Sunday morning. John Scott is sitting in an arm chair reading the newspaper. Jane is occupied with her doll, while Ann is busy at the table, trying to solve a crossword puzzle.]

Ann: Daddy.

Scott: Yes?

Ann: What is the name of the scientist who discovered a cure for hydrophobia?

Scott: What?

Ann: Hydrophobia.

Scott: Hydrophobia?

Ann: Yes.

Scott: What is hydrophobia?

Ann: I don't know.

Scott: Hm . . . Did you say he was a scientist?

Jane: I saw a beautiful red sign yesterday. It went on and off, on and off.

Ann: No Jane, not a sign—a scientist, a man who discovers new things. (*To Scott*) Seven letters, Daddy. The first two letters are Pa . . .

Scott: But first of all, what is hydrophobia?

Ann: I don't know.

Scott: Maybe mother knows. (*He calls*) Mother! What is hydrophobia?

Mrs. Scott: (*Enters the kitchen door*) What is it?

Scott: What is hydrophobia? Ann needs it for her crossword puzzle.

Mrs. Scott: (*Shrugs her shoulders*) So that's what you wanted me for? Hm, crossword puzzle. It's a puzzle to me too. You puzzle it out for yourselves. I better get started on my rhubarb pie. Come with me, Jane.

Jane: All right mother. (*Mrs. Scott and Jane go out*)

Scott: Don't you have a dictionary, Ann?

Ann: Sure.

Scott: Then why don't you look it up?

Ann: All right dad. (*She goes over to the bookcase and takes out a volume. She opens it and turns the pages*) Here it is. (*Reads*) Hydrophobia. (*Laughs*) Ha, ha, ha!

Scott: What's the matter?

Ann: (*laughing*) It says here that hydrophobia is . . . Ha, ha, ha! It's rabbis . . . Aren't rabbis Jewish preachers?

Scott: Certainly. So the dictionary says that hydrophobia is rabbis, eh?

Ann: That is what it says.

Scott: Impossible. (*He reaches for the book*) Let me see it.

Ann: (*Hands the book to him, pointing to the word*) Here.

Scott: (*Looks at the word and begins to laugh*) Ha, ha, ha! What a speller you are.

Ann: (*Sheepishly*) Why daddy?

Scott: Ho, ho, ho! It isn't rabbis. Rabbis is spelled r, a, b, b, i, s. This is rabies—r, a, b, i, e, s. What a speller. Ho, ho, ho! (*Mrs. Scott and Jane enter*)

Mrs. Scott: What is the big fuss about?

Scott: Ann says that hydrophobia is rabbis. Ho, ho, ho!

Mrs. S.: Ridiculous.

Scott: Of course. It's rabies—r, a, b, i, e, s. (*He reads from the book*) A disease communicated by the bite of a mad dog.

Jane: I don't like dogs.

Mrs. S.: So that's what it is? Come, Jane, let's finish the rhubarb pie. (*The door bell rings*) Answer the door bell, Ann.

Ann: All right, mother. (*She goes out*)

Scott: I hope it isn't Bill Truxon. He told me so much about the new car he bought that I got sick of it.

Vilma: (*Rushes in, followed by Ann*) Hello everybody! Congratulate me?

Jane: Hello, Vilma! Want to play house with me?

Vilma: A little later, darling. (*She looks a little disappointed to her uncle and aunt*) Well?

Scott: (*Rises and walks up pompously to Vilma, holding his hand high for a handshake*) Congratulations, my deah. Now which relative was it that died and left you his fortune? (*Points to himself*) Not this one, I'm sure.

Vilma: (*Peeved*) Oh, Uncle John.

Mrs. S.: Now Vilma Tuttle, you didn't run off and get married to that stringbean of a poet I saw you with last Sunday, did you?

Vilma: Absurd. (*Impatiently*) Oh, can't you guess?

Mrs. S.: I am not good at riddles. Are you?

Vilma: (*Unable to hold out any longer*) I got a scholarship to the University of Pennsylvania.

Scott: (*Blandly*) For what?

Mrs. S.: For dancing, I suppose.

Ann: (*Reproachfully*) Oh, mother.

Scott: Now, Vilma, do you mean to tell me that you were awarded a scholarship by your high school? How is it that they didn't say a word about it at the commencement?

Vilma: Not from the high school.

Scott: From your fairy godmother?

Vilma: No, from the city.

Scott: Wow! What an important personage! How come?

Vilma: I took a special examination. I did not want to say anything about it then, because I was afraid I'd fail.

Mrs. S.: It doesn't sound like you my dear, but I am glad just the same. (*She goes up to Vilma and kisses her*) Congratulations.

Ann: Congratulations, Vilma. (*They kiss*)

Jane: 'gratulations, Vilma. (*Vilma bends down and kisses her*)

Vilma: Thank you . . . You don't seem to be very glad, uncle John.

Scott: (*Hesitatingly*) Well, if you ask me, I'll tell you. I am, of course, glad that my sister's daughter has shown she has brains and is not afraid to use them, but I am not so sure that I approve of girls going to college.

Vilma: Why not?

Scott: Well, I am old fashioned enough to believe that a woman's place is in the home. And I have seen more than one girl graduate from college with a nose turned up to the sky. It is beneath their dignity to make a home for their husbands.

Vilma: Must a girl marry?

Scott: Well, I think she ought to.

Jane: I'm not going to get married.

Mrs. S.: Why not dear?

Jane: I won't marry a strange man.

Mrs. S.: I married a strange man, didn't I?

Jane: No, you didn't. You married daddy. (*There is general laughter and Jane feels offended and begins to cry*)

Mrs. S.: (*Takes Jane by the arm*) Come on, darling. You'll help me make the starch pudding, and then go out to play. This discussion is too high falutin for us anyhow. (*Exit to kitchen*)

Vilma: Now, Uncle John, I think you are mistaken. Every normal girl wants to marry.

Scott: Then what do you want to go to college for?

Vilma: For two reasons. In the first place I want a higher edu-

cation for the joy of knowing more than I do now. And in the second place, suppose I marry, and my husband loses his job, or is incapacitated or dies, would it not be desirable to be able to fall back on my profession and support myself . . . and perhaps my children?

Scott: Well, in that case it might be useful. (*Pause*) What do you intend to study in college? . . . I mean what do you want to specialize in?

Vilma: Science . . . Chemistry.

Scott: Chemistry? What will you do with it after you graduate?

Vilma: Research.

Scott: Search for what? A job?

Vilma: No, research. I mean I am going to try to discover new things.

Scott: Can you make money by it?

Vilma: (*Reproachfully*) Make money. Who wants to make money? I want to be useful.

Scott: And of what use will you be, pray?

Vilma: That I can't say. Anyhow I am going to try. Who can tell? I may discover something important.

Scott: And then, I suppose, you will be making money by the bushel.

Vilma: (*Peeved*) Money! Money!

Scott: Don't scientists like money?

Vilma: They may like it, but they don't worship it. Real scientists work because they enjoy it, yes, because they love science.

Ann: That's what I'd like to take. I asked daddy to let me take science next term, and he says a girl doesn't need any science.

Vilma: (*To Scott*) Why not?

Scott: What good will it do her? She is not going to college. I can see why a boy should take it; it will help him to make a living. But Ann . . . no. She'll get married and have a home. What does she need science for?

Vilma: Why Uncle John! For everything! Don't you know that this is an age of science? . . . It is always useful, everywhere. In the home as well as in business.

Scott: I see you've got science on your brain.

Mrs. S.: (*Enters. She looks worried*) John, I am afraid you won't have any rhubarb pie today.

Scott: Why not?

Mrs. S.: The rhubarb is so sour that it draws your mouth together like alum.

Scott: Put more sugar in it.

Mrs. S.: That won't help any. It will just make it sickeningly sweet, but the aftertaste will be terribly sour just the same. I told the fruitman to send me ripe rhubarb. Wait till I get hold of him.

Vilma: If you will let me, Aunt Mary, I think I can help you.

Scott: Page the professor.

Vilma: I am not a professor, but I think I can fix the rhubarb so it won't be so sour. Do you have any baking soda, Aunt Mary?

Mrs. S.: Yes, why? Do you have heartburn?

Vilma: No. I am thinking of how to fix your rhubarb. You see, the sourness is caused by a lot of acid. This can be neutralized with baking soda. Come on, auntie, let's try an experiment. You've got nothing to lose; the rhubarb is no good anyhow.

Ann: Yes, mother let's try. I love to watch experiments.

Mrs. S.: Well, since there is nothing to be lost, let's. (*Mrs. S., Vilma, and Ann leave toward the kitchen*)

Scott: (*Shouts after them*) Don't let her blow the house up. (*He takes the neswpaper and resumes reading*) Achew! ... I hope it isn't another cold. Gosh! These changes in the weather are terrible. (*He hurriedly runs his eyes through the newspaper.*) It ought to be here somewhere. (*Turns over a page*) Oh, here it is. (*He reads aloud*) "The successful candidates for the city scholarships are . . . " (*To himself*) Now let me see. Mm . . . mm . . . There. "Vilma Tuttle." A clever girl, by jove. In fact too clever, I'm afraid. (*He settles down to read. Mrs. Scott, Vilma and Ann return*)

Vilma: (*Proudly*) Well, Uncle John, science has proved its usefulness in the home this time. The operation is successful.

Scott: (*Looks up from his newspaper*) But the patient died?

Mrs. S.: Not at all, dad. It came out fine. I never heard of such a thing. The baking soda made the rhubarb less sour.

Scott: (*Ironically*) Hm, what a triumph!

Ann: And you should have seen how it fizzed, daddy—just like a Seidlitz powder. Didn't it mother?

Mrs. S.: It certainly did.

Scott: Is that so? My, my. By the way, Ma, since Ann reminded me about it, do we have a Seidlitz powder around the house?

Mrs. S.: (*Perturbed*) Why, no. Don't you feel well?

Scott: Nothing to worry about. I just feel a little full right here. (*He points to his solar plexus*) Must be gas or something. I thought a Seidlitz powder might fix me up.

Vilma: I can fix you up, Uncle John.

Scott: What? Practice on me? No, thanks!

Vilma: (*Peeved*) I am not going to practice on you. I'll only make you a Seidlitz powder, and it won't cost you a copper cent.

Scott: Oh, I see. Something for nothing, eh? Nothing doing. I always keep away from such people.

Ann: Do let her try, daddy. I want to see how it is done.

Scott: Even though it kills me, eh?

Vilma: You needn't be afraid, Uncle John. I'll try it on myself first if you like. It's only baking soda and vinegar.

Mrs. S.: I'll send Ann for some Seidlitz powders, shall I?

Scott: (*Scratches the back of his head*) Well, if it's only baking soda and vinegar I'll take a chance. A penny saved is a penny earned. Eh, what?

Vilma: (*Aglow with enthusiasm*) Ann, will you please bring me two glasses, some water, a teaspoon, the baking soda and the vinegar bottle?

Ann: Certainly. (*Exit to the left*)

Scott: Shall I write my will, Ma?

Mrs. S.: Don't mind your uncle, Vilma. He is just fond of kidding, that's all.

Vilma: I don't mind it in the least. I think the joke is going to be on him this time.

Scott: If that's the case I better begin to say my prayers right now.

Vilma: Oh, you purposely twist a different meaning into everything I say.

Mrs. S.: Now please stop that, John. You'll have the poor girl crying in a minute.

Scott: (*Good naturedly*) That's all right, Ma. Vilma can take it.

Ann: (*Enters laden with all the necessary materials*) Here you are, Vilma.

Vilma: All right. Thanks. (*She dissolves half a teaspoonful of baking soda in half a glassful of water and hands it to Scott, holding the teaspoon in her right hand.*) Hold that, please.

Scott: (*Examines the contents of the glass in his hand.*) So I am to mix my own poison, eh?

Vilma: No, I'll do that. Are you ready? You have to drink it fast, you know.

Scott: O.K. I am ready. (*He tries to look pathetic*) Good bye, Ma. Good bye, Ann.

Vilma: (*She pours the vinegar into his glass, stirring it with the spoon until it effervesces vigorously*) Now gulp it down. (*He does*)

Scott: (*He looks around slowly, pretending he is dazed.*) Where am I? (*He puts the glass down on the table and pinches his cheek*) Am I still alive?

Vilma: Well, Uncle John, how was it?

Scott: Not bad. (*He belches*) Ugh, pardon me. That's better. (*To Vilma*) Where did you learn that trick?

Vilma: Science, Uncle John. (*Pause*) And now I better be going. Don't forget to come.

Scott: Come where?

Mrs. S.: Landsakes! I've clear forgotten all about it in the excitement.

Ann: (*Enthusiastically*) They're having a party, daddy.

Scott: Who?

Vilma: (*Nonchalantly*) Oh, we are having a little family gathering to celebrate my scholarship.

Scott: (*Stiffly*) Oh, I see. A formal affair?

Vilma: (*Imitates him*) Very.

Ann: Mother, what will I wear?

Mrs. S.: Why, your organdy dress, dear.

Ann: I can't wear that, mother.

Mrs. S.: Why not?

Ann: There is an iodine spot on it. Don't you remember?

Mrs. S.: Goodness, yes. And it didn't wash out, either.

Scott: (*Sneezes*) Achoo! Achoo! Hm, I must have caught cold.

Vilma: If it's an iodine spot, Aunt Mary, I can take it out for you in a jiffy.

Scott: Look out, Ma! She will ruin the dress.

Vilma: Never mind, Aunt Mary. If you will send out Ann to the drug store for a few cents worth of hypo, I will take the spot out for you.

Mrs. S.: Sure thing. (*She gets her purse, takes out a coin and hands it to Ann*) Here, Ann. What did you call it, Vilma?

Vilma: Hypo.

Ann: (*Takes the money*) All right, I'll remember. Hypo. Will you wait, Vilma, until I come back?

Vilma: Certainly. Now hurry.

Ann: All right. (*Exit to the right*)

Scott: Wasted money.

Vilma: Not at all, Uncle John. You just wait and see.

Mrs. S.: Are you sure, Vilma, that stuff . . . I mean . . . that hypo won't make it worse?

Vilma: I am absolutely certain it will work, unless . . . (*She looks at Scott with a mischievous smile*)

Mrs. S.: (*Disturbed*) Unless what?

Vilma: Unless . . Uncle John casts an evil spell over the works.

Scott: Tommyrot!

Vilma: (*Teasing*) Don't you believe in evil spells, Uncle John?

Scott: (*Ironically*) Of course I do . . . when I see it.

Ann: (*Enters*) Here it is, Vilma. (*She hands Vilma something wrapped in a piece of paper*)

Vilma: Now get me the dress.

Ann: Right away. (*Exit to the right*)

Jane: (*Enters from the left*) Got a string, mother?

Vilma: Will you get me some water, Jane darling? I am going to show you some magic.

Jane: All right, Vilma. (*She puts down the doll on a chair and goes out at the left. Vilma unwraps the paper solemnly and examines the crystals carefully. Jane enters with the water.*) Here is the water, Vilma.

Vilma: Thank you. (*She takes the water and drops the crystals into it, shaking it with a circular motion. Everybody is looking on.*)

Ann: (*Enters with the dress*) Here is the dress, Vilma.

Vilma: Where is the spot? (*Ann shows it to her. Vilma examines it and raises it so that everybody can see it. She then makes a little fold, like a filter, with the spot in the center and soaks it in the hypo solution. They are all watching her intently.*)

Ann: It's gone! Like magic!

Jane: Magic!

Mrs. S.: It has certainly disappeared.

Scott: (*Won't admit defeat*) Hm.

Vilma: Science, Uncle John.

Scott: (*Sneezes*) Achoo! Achoo! It's a cold, all right. I better go upstairs and put some argyrol up my nose. I'll be right back. (*Exit to the right*)

Vilma: Now, Aunt Mary, you can just iron out the creases and everything will be all right.

Mrs. S.: Thanks, Vilma. I hope Uncle John hasn't irritated you

with his kidding. You know, he is an awful kidder. Sometimes he embarrasses me terribly when he gets started in the company of strangers. He doesn't mean to hurt anybody. Just a bad habit.

Ann: Daddy is an awful tease.

Vilma: I don't mind him in the least. I like Uncle John a lot—he is full of fun.

Jane: (*Fussing with her doll*) Got a string, mother?

Scott: Ouch! My nose! Help! Mary! (*He is heard running down the stairs*)

Mrs. S.: Goodness gracious! What has happened? (*She runs toward the door and meets Scott running in and holding his nose*)

Scott: Get the doctor! My nose! I am burning up! Water! Water! (*He runs back and forth like a madman holding his nose. Everybody is following him*)

Vilma: Run for the doctor, auntie. I'll attend to him. (*Mrs. Scott runs out at the right*) What did you do, uncle?

Scott: (*Still running around the stage*) I mistook the iodine bottle for the argyrol and squirted it up my nose. Oh, I am burning up! Get me some water! Oh, my nose!

Vilma: All right. (*She runs out into the kitchen and returns with a pot and some water in a glass. She slaps some of the stuff from the pot into the glass and stirs it quickly.*)

Scott: (*In agony*) What is it?

Vilma: Starch pudding.

Scott: Wha-a-a . . .

Vilma: Never mind. You'll ask questions later. Cup your hands! (*He obeys. She pours the milky liquid into his cupped hands.*) Inhale it! (*He does, producing a gurgling sound*) Deeply! Inhale it deeply and throw your head back to let it run down your throat. (*He obeys*) That's right. Now do it again. (*He does and sneezes*) How does it feel now?

Scott: Ugh. (*He heaves a sigh of apparent relief, facing the audience with his smeared face. He talks through his nose.*) Much better. Much better, thanks. (*He sinks into a chair with his smeared hands dangling helplessly.*) Will you get me a towel please? I guess I look like a half made up clown.

Vilma: Ann, Jane, get a dish towel or something, will you? (*The two children run out at the left and soon return with the towel, which Ann hands to her father. Scott begins to wipe his face. Mrs. Scott and the druggist run in.*)

Mrs. S.: Doctor Manning . . . Ugh . . . wasn't . . . home . . . Ugh . . . So I brought . . . the druggist . . . Ugh . . . (*She leans against the table, pressing her hand against her heart.*)

Druggist: What happened?

Vilma: Oh, nothing serious. Uncle John only mistook the iodine bottle for the argyrol and squirted it up his nose.

Druggist: You should have poured some starch water up his nose. Got any starch in the house?

Mrs. S.: Certainly. (*She makes a move to go to the kitchen*)

Vilma: Don't bother, Aunt Mary. I've already done that. Didn't I, Uncle John?

Scott: (*Grinning*) Yes, she fed me your starch pudding through the nose.

Vilma: It was the first starch I could lay my hands on.

Druggist: Good work, miss. (*Pause*) Well, I guess there is nothing left for me to do. Just rinse the nose with some warm water and follow it up with some mineral oil. Good bye.

Mrs. S.: I am so sorry I have troubled you. You see, Doctor Manning was out and I was so frightened . . . .

Druggist: That's all right, Mrs. Scott. I am glad everything turned out all right. Good bye.

Everybody: Good bye.

Mrs. S.: I am so glad you were here, Vilma, when the accident happened. I was frightened to death.

Scott: Make it two. But gosh, did that nose burn! I thought it was going to get singed right off. You know, Mary, this was the best starch pudding you've ever made. It certainly helped.

Vilma: Science, Uncle John!

Ann: I am going to take science next term, am I, daddy?

Scott: (*Smiling in defeat*) I guess so.

Ann: (*Joyous*) Hooray! Science wins!

Scott: (*Grinning*) Yes, science wins by a nose.

NEW-FOUND STRAIN OF YEAST GROWS AT TEMPERATURES BELOW FREEZING

Yeast that will grow at temperatures below freezing point has been discovered growing in cider, by James A. Berry of the frozen pack laboratory of the U. S. Department of Agriculture. Mr. Berry isolated cells of the new strain of yeast, and grew cultures from them in beer wort at 28 degrees Fahrenheit, 4 degrees below the freezing point of water. Despite its chilly environment, the yeast grew freely.

A LIST OF OBJECTIVES FOR CULTURAL NATURAL SCIENCE IN THE JUNIOR HIGH SCHOOL

By P. A. Maxwell
State Teachers College, Peru, Nebraska

The New Deal has brought sharply to the front of American thought a recognition of the trend toward universal leisure. For some years this trend has been sensed by leading educational theorists many of whom have seen therein a new responsibility for the public school. Variously stated as "worthy use of leisure," "cultural efficiency," "recreation," "aesthetic adjustment," "the avocational aim," and the like, one of the major educational objectives now commonly taken for granted embodies a class of activities usually associated with leisure.

That interest in this educational objective lately has been growing is evidenced by the large amount of space devoted to education for leisure in recent pedagogical literature. In general, however, the discussions of this subject that consider possible sources of specific objectives and the selection of curriculum materials are concerned almost exclusively with the arts. The rich storehouses of avocational values found within the realms of science have been largely ignored.

This lack of consideration for the avocational possibilities of the sciences no doubt is due somewhat to a lack of emphasis in science teaching upon cultural goals. That such goals are not generally stressed by science teachers is not surprising. Only recently has the significance of definite educational objectives other than subject-matter masteries been recognized. Moreover the fertility of the sciences in relation to the more practical objectives of education very likely has tended to obscure their cultural potentialities. At any rate it now seems rather obvious that science teachers can and, perhaps, should aid materially in revealing the abundant avocational values resident in their subjects by stressing avocational goals and adapting materials and procedures thereto.

In another place[1] the writer has proposed a theoretical basis for science teaching having the cultural or avocational aim which may be summarized briefly as follows:

1. There is a growing tendency for school administrators and curriculum

[1] Maxwell, P. A. *Cultural Natural Science for the Junior High School*. Williams and Wilkins.

specialists to think in terms of major types of education, or guidance, corresponding to the leading objectives of education.

2. This tendency is in harmony with sound principles of social psychology.

3. One of the major embryonic educations is education for leisure which should include cultural natural science as one of its principal sub-divisions.

4. Cultural natural science is distinctly different from vocational science, civic science, or health science.

5. Objectives of cultural natural science may be defined as growths in desire and ability to achieve pleasant and wholesome diversion through the appreciation of natural science themes.

6. Procedures in cultural natural science should be characterized by relatively large amounts of pupil freedom and curriculum variation.

A list of themes suitable for junior high school cultural natural science is presented in Table I. The one hundred and eight themes in this list were selected from a preliminary list of four hundred and twenty-one themes on the basis of valuations made by sixteen judges.[2] The themes are listed in order of value. The value given for each theme is the average of the values assigned by the sixteen judges according to a scale in which zero signifies "little or no value," fifty signifies "moderate value," and one hundred signifies "high value."

TABLE I

THE FINAL THEME LIST

	VALUE	RANK
1. What we owe to Louis Pasteur—founder of preventive medicine	100	1
2. Man learns to fly—the story of the invention of the airplane	97	2
3. Alexander Graham Bell invents the telephone—teacher of deaf becomes benefactor of all mankind	97	2
4. Gregor Mendel and family traits—famous experiments in heredity	94	4
5. The story of the steam engine—how it was invented and improved	94	4
6. The moon—curious facts about our nearest celestial neighbor	91	9
7. Our flaming friend—what we know about the sun	91	9
8. William Harvey's epochal discovery—first to realize that the blood circulates	91	9
9. The master inventor—Thomas Edison and his great works	91	9
10. Insect versus man—a bitter contest for the world's food supply	91	9
11. Through the ether—marvels of the radio	91	9
12. The United States Bureau of Standards—great research agency of our federal government	91	9

[2] The names of the valuators may be found on page 81 of the author's *Cultural Natural Science for the Junior High School.*

TABLE I (*Continued*)

	VALUE	RANK
13. Travels of our feathered friends—about bird migration.	88	18
14. The story of the horse—his past, present, and future...	88	18
15. Wonder work of plants—the place of green plants in the balance of life	88	18
16. Sparks and shocks—what we know about electricity...	88	18
17. Charles Darwin and evolution—he reveals the principle of natural selection	88	18
18. Luther Burbank, plant wizard—creator of many wonderful new plants	88	18
19. Joseph Lister introduces aseptic surgery—immense boon to humanity	88	18
20. Saving the forest—maintaining our valuable lumber resources	88	18
21. Giant water power projects—energy of falling water carried to distant points	88	18
22. The science of flight—how the airplane works	88	18
23. Railroad engineering feats—bridging giant chasms and tunneling through mountains	88	18
24. Star wonders—marvelous revelations of modern astronomy	84	29
25. Bee ways—strange customs of the hive	84	29
26. Our faithful friend, the dog—the story of man's favorite pet	84	29
27. Sir Isaac Newton—how he formulated the principle of gravitation	84	29
28. Richard Byrd—his heroic scientific exploits	84	29
29. The Andrews expedition—remains of prehistoric monsters found in the Gobi desert	84	29
30. The story of the telegraph—its invention and perfection	84	29
31. Edward Jenner turns the smallpox tide—founds the principle of inoculation	84	29
32. Benjamin Franklin, first great American scientist—the story of his experiments	84	29
33. Famous bridges—marvelous achievements of engineer and architect	84	29
34. Making the movies—how motion pictures are produced	84	29
35. Stories told in the rocks—strange plants and animals of former times	81	43
36. The most marvelous machine—the human body	81	43
37. The story of hot and cold—the strange ways of heat energy	81	43
38. Secrets of the rainbow—the story of color	81	43
39. What's in a sound?—how agitated bodies send messages to our ears	81	43
40. Robert Peary, arctic explorer—discovers the North Pole	81	43
41. Robert Koch, pioneer microbe fighter—isolates germ of great white plague	81	43
42. Walter Reed solves yellow fever enigma—proves mosquito carries the germ.	81	43
43. Sir Ronald Ross conquers malaria—finds the mosquito carrier	81	43

TABLE I (*Continued*)

	VALUE	RANK
44. Antoine Lavoisier, "Father of Modern Chemistry"—penetrates mystery of fire	81	43
45. Madame Marie Curie discovers radium—story of the wonder element	81	43
46. Guglielmo Marconi conquers the ether—makes the first wireless	81	43
47. The most useful metal—iron mining and smelting and steel making	81	43
48. The story of coal—how the veins were formed, how and where the coal is mined	81	43
49. The story of photography—science of picture taking and making	81	43
50. Germ caging—maintenance of health by quarantine and other preventive measures	81	43
51. Scientific research in industry—how modern business plans for progress	81	43
52. Weather prediction—a great scientific project and its limitations	81	43
53. Our sky partners—facts about the planets	78	61
54. When the earth was young—formation of the ball on which we live	78	61
55. The earth changes its face—about forces that slowly reshape the earth's surface	78	61
56. Little beings—fascinating creatures revealed by the microscope	78	61
57. Little cave dwellers—about ants and their wondrous ways	78	61
58. A master builder—the beaver and its interesting work	78	61
59. The races of man—the story of our kin	78	61
60. Our native trees—their marks of identity	78	61
61. Bulbs and tubers—underground structures in which plants store their food	78	61
62. The mystery of a magnet—the fascinating story of magnetism	78	61
63. John James Audubon, revealer of bird life—how he prepared his "Birds of America"	78	61
64. William Morton conquers pain—discovers anesthetic power of ether	78	61
65. Joseph Priestley discovers oxygen—first to identify the commonest element	78	61
66. Michael Faraday, wizard of electricity—paves the way for the dynamo, telephone, and telegraph	78	61
67. Wilhelm Roentgen and the X-ray—how modern marvel was discovered	78	61
68. Keeping the soil fertile—how science meets a crucial need of the farmer	78	61
69. The great petroleum industry—the oil fields of the world, their origin and development	78	61
70. Modern highways—wonders of twentieth century road building	78	61
71. Building the solar system—life story of sun and planets	75	75

TABLE I (*Continued*)

	VALUE	RANK
72. When the earth quakes—what science has revealed about our trembling globe	75	75
73. Bright wings and tricky tongues—our familiar moths and butterflies	75	75
74. Lifting the veil from our precursors—about the prehistoric people of the earth	75	75
75. Galileo, father of modern science—epochal discoveries and inventions	75	75
76. Robert Fulton and the Clermont—launching of the first successful steamboat	75	75
77. Bringing life to the desert—about great irrigation projects	75	75
78. Keeping the flow—how huge cities are supplied with water	75	75
79. Famous canals—digging great ditches for ships to pass through	75	75
80. Achievements in accident prevention—combating dangers of modern life	75	75
81. Marvels of the milky way—its importance in the plan of the universe	72	94
82. Mysterious messengers from the sky—about meteors and meteorites	72	94
83. Giant shadows—eclipses and what they reveal	72	94
84. Nature's huge fire-pots—stories of famous volcanoes	72	94
85. Caves and caverns—their enchanting mysteries	72	94
86. Origin and destiny of the rocks—how Nature builds up and tears down mighty structures	72	94
87. Autumnal spectacles—gorgeous fall displays of trees and flowers	72	94
88. Giant sequoias—the story of the world's largest trees	72	94
89. Nature's spring opening—beauties of field and forest as plants bud and sprout	72	94
90. Building materials of nature—about the chemical elements	72	94
91. In the realm of the molecule—the patterns of all substances of nature	72	94
92. Roald Amundsen, discoverer of the South Pole—his bold adventures in the polar regions	72	94
93. The story of rubber—how vast tropical plantations supply us with a basic raw material	72	94
94. Treasures from coal—how dyes, perfumes, flavors, and drugs are extracted from the black rock	72	94
95. Wild life preserves—how the hunted species are protected from extinction	72	94
96. Making an automobile—a glimpse at a gigantic industry	72	94
97. From raft to ocean liner—the story of boats	72	94
98. Secrets of television—how pictures are flashed through space	72	94
99. The magic network—gigantic telephone system binds world together	72	94

TABLE I (*Concluded*)

	VALUE	RANK
100. The talking machine industry—putting entertainments in storage	72	94
101. Science of music—scientific foundations of a great art	72	94
102. Historic dreams that have come true—hopes that were scoffed at, now realities	72	94
103. Hunting wild life with the camera—how beasts are made to take their own pictures	72	94
104. The great observatories of the world—their work and equipment	72	94
105. Science a world enterprise—all nationalities co-operate in the pursuit of knowledge	72	94
106. Saving human energy—power, machines, and the work of the world	72	94
107. Keeping time—setting the standard for the world's calendars and timepieces	72	94
108. In the biological laboratory—methods of studying living things under controlled conditions	72	94

THE 34TH ANNUAL CONVENTION

GENERAL PROGRAM

Friday Morning, Nov. 30th, 1934

8:30 *Music Instrumental Trio,* Music Department, Arsenal Technical Schools, Indianapolis, Ind.

8:45 *Address of Welcome,* Daniel T. Meir, Ass't. Supt. Schools, Indianapolis, Ind.

9:00 *Response for the Association,* O. D. Frank, University of Chicago, Chicago, Ill.

9:10 *Greetings from the N.E.A.,* Dean H. L. Smith, University of Indiana, President of N.E.A.

9:30 *The Conservation Policy of the National Park Service,* Dr. H. C. Bryant, Ass't. Director of National Park Service, Washington, D. C.

10:15 *A Modern Sanitation System,* Mr. Calvert, Indianapolis Sanitation Plant.

10:45 *Can Man's Group Activity Be Measured?* Dr. Harold T. Davis, University of Indiana.

11:30 *New Concepts of Secondary Education and Resulting Curriculum Reorganization,* Dr. J. E. Stout, School of Education, Northwestern University.

Friday Evening, Nov. 30th, 1934

6:00 *Dinner*

6:30 *Pipe Organist,* Christine Houseman, Music Department, Shortridge High School, Indianapolis, Ind.

7:30 *Speaking Choir,* George Washington High School, Indianapolis, Ind.

8:00 *Introduction of Toastmaster,* Katherine Ulrich, President.

8:05 *Science Ahead of Us*, Dr. Otis W. Caldwell, Toastmaster, Columbia University.
Introduction of Guests of Honor.
8:20 *Indiana's Noted Scientists,* Dr. Fernandus Payne, Dean of the Graduate School, Indiana University.
8:40 *Science and Mathematics in the Newspapers,* A Representative of the Indianapolis Press.
9:00 *Science and the New Public,* Dr. Will D. Howe, Charles Scribner's Sons, New York.
9:20 *Mathematics and Engineering Education,* Dr. C. A. Ellis, Structural Engineering, Purdue University.
9:40 *The Philosophy of Science Teaching,* Dr. W. L. Beauchamp, University of Chicago, Chicago, Ill.

Saturday Morning, Dec. 1st, 1934

8:15 *Business meeting.*
9:45 *Applications of Mathematics in Civil Engineering,* W. S. Howland, Ass't. Prof. of Sanitary Engineering, Purdue University.
10:30 *The Mathematics and Science Behind Air Conditioning,* Mr. Roy M. Moffitt, Engineer, Fairbanks Company, Chicago, Ill.
11:15 *Gold and Precious Stones Found in Indiana,* (Illustrated), Mr. Frank B. Wade, Shortridge High School, Indianapolis, Ind.
11:45 *Demonstration-Lecture on Recent Advances in Industrial Physics or Chemistry.*

Luncheon 12:30–1:30

A luncheon for heads of Science and Mathematics Departments will be held in Hotel Lincoln, at 12:30 P.M., Friday, Nov. 30th. Register for this luncheon at the registration desk.

Reception—Tea

4:30–6:00 P.M.

The Indianapolis Chapter of the Council of Administrative Women in Education will have charge of the Reception. Tea will be served near the exhibits. Exhibitors will arrange special demonstrations during these hours.

Excursions

Excursions to various places of interest will be arranged between the hours of 3:30 and 6:00 P.M., Friday, Nov. 30th, for those interested. Register for these excursions at the registration desk. An all-day excursion to Brown County is planned if weather permits. Frank B. Wade will be leader of this expedition.

Visiting Guests

Friday 1:30–3:30 P.M.; Saturday A.M.

Special entertainment is being planned for wives and other relatives of members. Details will appear in the Year Book.

Exhibits

In addition to the usual commercial exhibits of books and apparatus there will be an exhibit of hobbies of a non-commercial nature. A telescope made by amateurs, airplanes, speed boats, plant and insect collections, gems, etc., will be on exhibit. There will also be an exhibit of the "Composite Scientist" painting being painted by Mr. Taflinger of Indianapolis.

Breakfast 7:00–8:15 a.m.

The Indianapolis Chapter of Phi Lambda Theta are sponsoring a Women's breakfast, at 7:00 A.M., Saturday morning. Register at the registration desk.

8:00 ——————————————. Agnes E. Wells, Dean of Women, Indiana University.

SECTION PROGRAMS

Friday, Nov. 30th, 1:30–3:30 P.M.

BIOLOGY SECTION

The Psychological Basis of the Unit Method, Dr. W. L. Beauchamp, University of Chicago

Bringing 'Em Back to Life, Wes Minear, Quincy High School, Quincy, Illinois

ELEMENTARY SCIENCE SECTION

A Demonstration Lesson with Fourth Grade Children, Lillian Hethershaw, Drake University, Des Moines, Iowa

Limestone: A Sixth Grade Science Unit, Helen Dolman, Michigan State Normal College

Factors Conditioning the Development of Science Understandings, Geraldine Shontz, Training School, Indiana State Teachers College

Materials and Equipment for the Elementary School Program, Ellis C. Persing, Western Reserve University

GENERAL SCIENCE SECTION

General Science in Indianapolis, Carl F. Hanske, Manual Training High School, Indianapolis, Indiana

Best Use of the General Science Textbook, Ellsworth S. Obourn, John Burrough School, St. Louis, Missouri

Outside Aids in Teaching General Science, J. O. Frank, Oshkosh Normal College, Oshkosh, Wisconsin

GEOGRAPHY SECTION

A Summer in Spain, Helen Turner, Oak Park High School, Oak Park, Illinois

Science Teaching in the National Parks, Dr. Harold C. Bryant, Ass't. Director, National Park Service, Washington, D. C.

Gypsying on a Budget, Robert Auble, Arsenal Technical Schools, Indianapolis, Indiana

Motion Picture Sketches, R. B. Annis, Indianapolis, Indiana

PHYSICS SECTION

The Place of Physics in the American Public School System, Earl R. Glenn, Prof. of Physics and Head of the Science Department, New Jersey State Teachers College

The Romance of Research, Mason E. Hufford, Associate Prof. of Physics, University of Indiana

The Single Laboratory Period a Demonstrated Success, H. Clyde Kreverick, North Division High School, Milwaukee, Wisconsin

MATHEMATICS SECTION

What Mathematics is Necessary for Success in College, Dr. Dyer, Antioch College

What Mathematics to Teach in Junior High School and How to Teach it, Dr. Breslich, University of Chicago

How Periodic Elements are Discovered in Statistical Series, Dr. H. D. Davis, University of Indiana

CHEMISTRY SECTION

A Modern View of the Science of Chemistry, Dr. E. A. Wildman, Earlham College

What Shall We Teach in Chemistry? G. M. Bradbury, Lakewood High School, Cleveland, Ohio

Technology of Coal Tar, Dr. I. H. Derby, Head of Research Laboratories, Reilly Chemical Corporation, Indianapolis, Indiana

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1336—Frank G. Carlson, Bridge, Oregon.

1338—Charles W. Trigg, Los Angeles.

1335—Criag L. Smith, Missoula, Montana.

SOLUTION OF PROBLEMS

1340. *Proposed by Charles W. Trigg, Cumnock College, Los Angeles.*

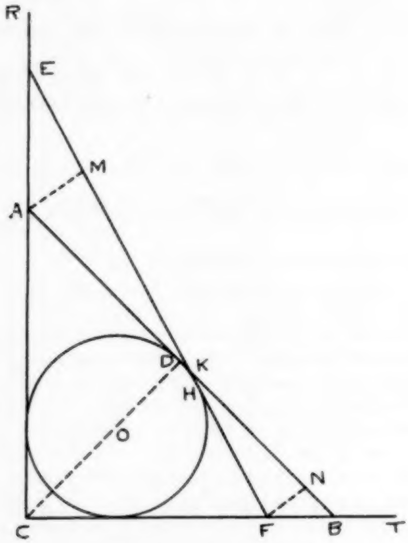
Of all the right triangles circumscribed about a given circle, the isosceles right triangle has the minimum hypotenuse. Prove geometrically.

Solution by the Proposer.

Given: $RC \perp CT$. Circle, O, tangent to RC and CT.

Construction: Draw COD through the center of the circle, cutting the circle at D. Draw AB tangent to the circle at D and cutting RC at A and CT at B. At any point, H, other than D, draw EF tangent to the circle and cutting RC at E, AB at K, and CT at F. With K as center and radii equal to AK and KF, respectively, describe arcs cutting KE at M and KB at N, respectively. Connect A and M, F and N.

To Prove: $EF > AB$.



Proof: O is the center of the inscribed circle.
CD is bisector of $\angle ACB$, which $=90°$.
$\angle ACD = 45°$.
AB is tangent to circle, O.
$AD \perp CD$, and $\angle ADC = 90°$.
$\angle CAD = 45°$ and $\angle ABC = 45°$.
$\triangle ACB$ is isosceles and $AC = CB$.
$AD + DK = AK$, so $AK > AD$
$AD = DB$
$DK + KB = DB$, so $DB > KB$
$KB = KN + NB$, so $KB > KN$
$\therefore$ $AK > KN$
$AK = MK$ and $KN = KF$
$\triangle AKM$ and $\triangle FKN$ are isosceles.
$\angle AKM = \angle FKN$
$\angle MAK = \angle AMK = \angle KFN = \angle KNF$
$\triangle AKM \sim \triangle FKN$
(1) $\therefore$ $AM > FN$
$\angle AKE + \angle AEK = \angle CAB = 45°$.
$\angle AEM = \angle AEK < 45°$
$\angle MAK + \angle AMK < 180°$
$\angle MAK < 90°$
$\angle CAB + \angle MAK < 135°$
$\angle EAM = 180° - (\angle CAB + \angle MAK) > 45°$
$\angle EAM > \angle AEM$

(2) $\therefore$ $EM > AM$ and from (1) $EM > FN$.

$\angle KNF + \angle KFN < 180°$

$\angle KNF < 90°$

$\angle FNB > 90°$

$\angle NBF = 45°$

$\angle NBF + \angle FNB > 135°$

$\angle NFB = 180° - (\angle NBF + \angle FNB) < 45°$

$\angle NBF > \angle NFB$

$\therefore$ $FN > NB$ and from (2) $EM > NB$

Since $EM > NB$

and $MK = AK$

and $KF = KN$

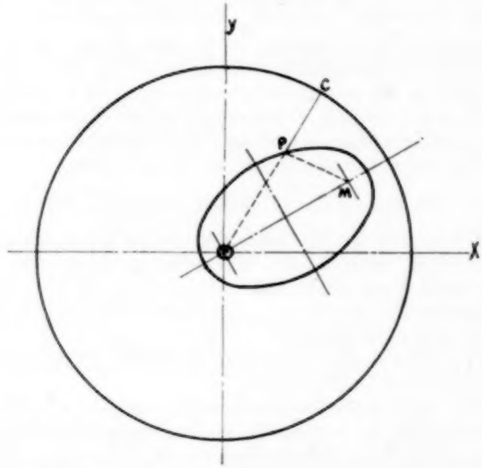
$\therefore$ $EM + MK + KF > AK + KN + NB$

or $EF > AB$.

1341. *Proposed by Franklyn Olson, Wilmette, Illinois.*

What is the locus of all points equally distant from a given circle and a point within the circle?

Solution by A. MacNeish, Chicago.



Given: The circle with center O and M any point within the circle.

To find: the locus of all points equally distant from the circle and the point M.

Let P be any point of the required locus, and OC be the radius passing through point P.

Then PC must equal PM according to the conditions of the locus. Therefore $OP + PM = OC$, the radius of the circle, and a constant. Therefore P must lie on an ellipse whose foci are O and M, such that the sum of the distances from the foci to any point of the ellipse equals the radius of the circle. This ellipse is shown in the figure.

Note: Mr. Roy MacKay mentions that if M is without the circle the locus is an hyperbola. Also if P is not restricted to the plan of the circle, the required locus becomes an elliptic cylinder. Also solved by

Aaron Buchman, Brooklyn, Maxwell Reade, B. Hugh, Indianapolis, W. E. Buker, Leetsdale, Pa., Criag Smith, Missoula, Mont., Charles W. Trigg, Los Angeles, Lester Dawson, Wichita, Kan. and the proposer.

1342. *Proposed by a teacher.*

The area of a triangle is equal to one-fourth the square root of twice the sum of the products of the squares of the adjacent sides diminished by the sum of the fourth powers of the sides.

Solution by Roy MacKay, Albuquerque, New Mexico.

This is Heron's formula for the area of a triangle stated in a slightly different form. If we replace s, $(s-a)$, $(s-b)$, $(s-c)$ by $\frac{1}{2}(a+b+c)$, $\frac{1}{2}(-a+b+c)$, $\frac{1}{2}(a-b+c)$ and $\frac{1}{2}(a+b-c)$ in the usual formula, there results:

$$\begin{aligned}\text{Area} = \{s(s-a)(s-b)(s-c)\}^{1/2} &= \tfrac{1}{4}\{(a+b+c)(-a+b+c)(a-b+c)(a+b-c)\}^{1/2}\\ &= \tfrac{1}{4}\{2(a^2b^2+b^2c^2+c^2a^2)-(a^4+b^4+c^4)\}^{1/2}.\end{aligned}$$

Also solved by A. MacNeish, Chicago, Maxwell Reade, Lester Dawson, Wichita, Kan. and Charles W. Trigg, Los Angeles.

1343. *Proposed by Stanley Jashemski, Youngstown, Ohio.*

Given a balance and a number of weights whose total weight is N pounds. By various combinations of weights and by placing them on both scales it is possible to make any weighing consisting of a whole number of pounds between 1 pound and N pounds. The problem is to determine the weight of every weight if it is known that the number of weights is the smallest possible under the conditions of the problem.

Solution by W. E. Buker, Leetsdale, Pa.

It is possible to verify the fact that a series of weights of 3^0, $3'$, $3^2, \cdots, 3^{n-1}$ pounds, respectively, will suffice to weigh any integral number of pounds from 1 pound to $\frac{1}{2}(3^n-1)$ pounds. If N is given, then the weights required are 3^0, $3'$, $3^2, \cdots, 3^n$ where n is equal to $[\log(2N+1)]/\log 3$ if $2N+1$ is a multiple of 3.

The above result was given by Bachet in his "Problêmes plaisans et délectables" as early as 1612.

The method of finding the least number of weights, all different, to make all integral weighings to n pounds, inclusive, as well as proof that the method actually achieves the desired result, was given by MacMahon, Quarterly Journal of Mathematics, 1886, Vol. 21, pp. 367–373. The method is as follows:

Write the expression $X^{-n}+X^{-n+1}+\cdots+1+\cdots+X^{n-1}+X^n$, (1)
and resolve it into factors of the form $X^{-ma}+\cdots+X^{-a}+1+X^a+\cdots+X^{ma}$. This is best done by writing (1) in the form (2)
$(1-X^{2m+1})/X^m(1-X)$. (3)

Each factorization of (1) into expressions of the form (2) yields a separate set of weights.

Corresponding to each set of factors of (1) giving distinct values for a and m, we get a set of weights satisfying the conditions of the problem. There are m weights each weighing a pounds. The number of solutions depends on the composite nature of $2m+1$, as is apparent from (3).

As the above method yields all possible sets of weights which can be used to weigh all integral weights from 1 to n pounds, inclusive, the set of weights, all different, having the least number of weights can be picked out.

Reference:

Ball, "Mathematical Recreations and Essays"; 1922, Macmillan, pages 34–36.

1344. *Proposed by Clyde Rosser, Gaston, Ore.*

The area of an inscribed regular polygon having an even number of sides is the mean proportional between the areas of regular inscribed and circumscribed polygons having half as many sides.

Solved by Aaron Buchman, Brooklyn, N.Y.

It is easily shown that the area of a regular polygon of t sides inscribed in a circle of radius r is

$$K = \tfrac{1}{2}tr^2 \sin(2\pi/t) \tag{1}$$

(draw radii to vertices and use $K_1 = \tfrac{1}{2}ab \sin C$ for each triangle).

It is easily shown that the area of a regular polygon of t sides circumscribed about a circle of radius r is

$$K = tr^2 \tan(\pi/t) \tag{2}$$

(draw radii to points of contact, connect center to vertices and find area of the right triangles formed).

Let U be the area of the regular polygon of $2n$ sides inscribed in circle of radius $= r$.

Let V be the area of the regular inscribed polygon of n sides and W the area of the regular circumscribed polygon of n sides. Then we must prove the identity

$$U = \sqrt{VW}.$$

Use formulas (1) and (2) to substitute for U, V, and W

$$\frac{1}{2}(2n)r^2 \sin\frac{2\pi}{2n} = \sqrt{\left(\frac{1}{2}nr^2 \sin\frac{2\pi}{n}\right)\left(nr^2 \tan\frac{\pi}{n}\right)}$$

$$nr^2 \sin\frac{\pi}{n} = \sqrt{\left(nr^2 \sin\frac{\pi}{n}\cos\frac{\pi}{n}\right)\left(nr^2\frac{\sin\frac{\pi}{n}}{\cos\frac{\pi}{n}}\right)}$$

$$nr^2 \sin\frac{\pi}{n} = \sqrt{n^2r^4 \sin^2(\pi/n)}$$

$$nr^2 \sin\frac{\pi}{n} = nr^2 \sin\frac{\pi}{n}\cdot$$

Also solved by Charles W. Trigg, Los Angeles, W. E. Buker, Leetsdale, Pa., Roy MacKay, Albuquerque, New Mexico, A. MacNeish, Chicago and J. P. Ludington, Irvington, N. Y.

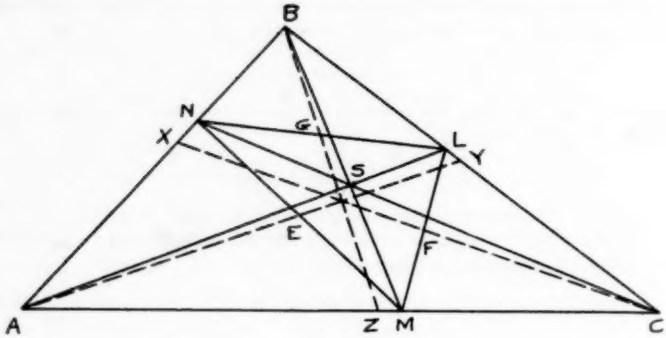
1345. *Proposed by D. Moody Bailey, Belsprings, Va.*

A triangle, ABC, with cevians AL, BM, and CN intersecting in S is given. Let lines be drawn from A, B and C, bisecting MN, NL and LM respectively. The three lines thus drawn are concurrent.

Solution by Charles W. Trigg, Cumnock College, Los Angeles.

Given: $\triangle ABC$ with cevians AL, BM and CN intersecting in S.

Line BZ, through G, to the mid-point of NL meeting AC in Z.
Line AY through E, the mid-point of NM, meeting BC in Y.
Line CX through F, the mid-point of ML, meeting AB in X.



To Prove: AY, BZ and CX are concurrent.

$$\frac{\triangle BGL}{\triangle BZC}=\frac{BG\cdot BL}{BZ\cdot BC}. \tag{1}$$

(Two triangles having an angle of one equal to an angle of the other are to each other as the products of the sides including the equal angles.)

$$\frac{\triangle ABZ}{\triangle NBG}=\frac{AB\cdot BZ}{BN\cdot BG}. \tag{2}$$

$$\triangle BGL=\triangle BNG. \tag{3}$$

(Triangles having equal bases and equal altitudes are equal.)

$$\frac{\triangle ABZ}{\triangle BZC}=\frac{AZ}{ZC}. \tag{4}$$

(Triangles having equal altitudes are to each other as their bases.)

Multiplying (1) and (2), as substituting the values from (3) and (4) in the resulting equation,

$$\frac{AB\cdot BL}{BN\cdot BC}=\frac{AZ}{ZC}. \tag{5}$$

In like manner,

$$\frac{AN\cdot AC}{AB\cdot AM}=\frac{CY}{YB} \tag{6}$$

Also

$$\frac{MC\cdot BC}{AC\cdot CL}=\frac{BX}{XA}. \tag{7}$$

Multiplying (5), (6) and (7) and simplifying,

$$\frac{BL\cdot AN\cdot MC}{BN\cdot AM\cdot CL}=\frac{AZ\cdot CY\cdot BX}{ZC\cdot YB\cdot XA}.$$

By Ceva's theorem,

$$BL\cdot AN\cdot MC = BN\cdot AM\cdot CL.$$

Substituting this value in (8) and clearing of fractions,

$$AZ\cdot CY\cdot BX = ZC\cdot YB\cdot XA.$$

$\therefore$ By the converse of Ceva's theorem, AY, BZ and CX are concurrent.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

PROBLEMS FOR SOLUTION

1358. *Proposed by John Angel, Kemp, Texas.*

If a, b, c, are sides of a triangle, and t_a the bisector of angle A, prove that

$$t_a^2 = bc - \frac{ba^2c}{(b+c)^2}\cdot$$

1359. *Proposed by Maxwell Reade, Brooklyn, N.Y.*

Bisect the angle formed by two non-intersecting, non-parallel lines without prolonging the lines to their point of intersection.

1360. *Proposed by Maxwell Reade, Brooklyn, N.Y.*

Fine the sum to infinites:

$$\frac{3}{18}+\frac{3\cdot 7}{18\cdot 24}+\frac{3\cdot 7\cdot 11}{18\cdot 24\cdot 30}+\cdots$$

1361. *Proposed by Norman Anning, University of Michigan. (Adapted from Newton's pasture problem.)*

If 6 cattle annihilate 4 acres of pasture in 25 days, and 8 cattle annihilate 5 acres in 20 days, find the smallest field that can be stripped by 10 cattle. not It is assumed that the grass grows at same rate, that the cattle eat at same rate, and that the grass is uniformly distributed when cattle are turned in.

1362. *Proposed by Maxwell Reade, Brooklyn, N.Y.*

Find the indefinite integral without using the half angle substitution formula:

$$\int \frac{a \sin x + b \cos x}{e \sin x + d \cos x}\, dx \text{ with } c^2+d^2\neq 0.$$

1363. *Proposed by William Kent and Emmett Durrum, Lewis and Clarke H. S., Spokane.*

A man arrives at a railway station $1\frac{1}{2}$ hours before the time at which he had ordered his carriage to meet him. He sets out to walk at 4 miles per hour; he meets his carriage when it has travelled 8 miles, and reaches home one hour sooner than he had originally expected. How far did he live from the station and at what rate was the carriage driven, assuming that it had left his home so as to reach the station exactly at the time ordered?

SCIENCE QUESTIONS

**Conducted by Franklin T. Jones, 10109 Wilbur Avenue
Cleveland, Ohio**

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio. Thanks.

NUTTY STUFF FOR THE GQRA

675. *Suggested by a once-Pennsylvania Farmer, now GQRA, No. 6.*

Pennsylvania Rye

a. A Pennsylvania farmer tells the story that you can set a sheaf of dry rye afire by riding it like a sled down a steep icy hill-side.

What about it?

b. Is this the same principle involved in the heating of a meteorite on its passage through the air?

c. The Big Bad Wolf strikes sparks on the road as he slides out of the picture "The Three Little Pigs." What is scientifically wrong?

TEACHERS!!! *Put up these problems and questions to your classes. Get into GQRA!*

You and/or your class become members of the **GUILD OF QUESTION RAISERS AND ANSWERS** (GQRA) when you send an accepted communication to **SCIENCE QUESTION DEPT.** of SCHOOL SCIENCE AND MATHEMATICS.

Have your class answer or propose a question.

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676. *Some Simple Questions for GQRA. Suggested by reading "The Automobile Buyer's Guide"* (Copies may be obtained by applying to Henry G. Weaver, Director, Customer Research Bureau, General Motors, Detroit, Mich.)

1. Why does a top "wobble"?
2. Why do gas engine pistons "pound"?
3. Why are not the crankpin and counterbalance side of a locomotive wheel alike? In what respect are they alike?
4. Is there anything similar on an old-fashioned foot-power sewing machine?
5. Why does the electric washing machine "vibrate" at high speeds? How correct it?
6. When is an auto crankshaft "balanced"? State some devices for balancing a crankshaft.
7. State the fundamental physical principle (or principles, if there are any) involved in questions 1 to 6.

677. *Proposed by L. E. Hebl, Woodriver, Illinois.* (*Elected to GQRA. No. 40*)

WOULD ALL OF MISS PETERS' BOYS STEAL ICE CREAM?

Miss King learned, by some means or other, that two of the seven boys who stole the ice cream for her class picnic wore long pants. Thereupon she accused all the boys of Miss Peters' class of participating in the theft because there were just seven boys in Miss Peters' class. Miss Peters couldn't believe that all her boys would steal because none of the rascally Johnsons or Joneses were in her class (the Johnson and Jones boys were the only red-headed boys in the school). The principal, Miss Smith, settled the question quickly with the observation that all the boys over ten years old had red hair and all those under ten wore short pants, and that therefore at least some of the boys who stole Miss King's ice cream must have been from one of the other classes besides Miss Peters'. Why?

TESTS FOR CLASSES IN PHYSICS

678. *Proposed by Paul E. Wilson, Missoula County High School, Missoula, Montana.* (*Elected to GQRA, No. 41*)

TRY THE TESTS BELOW ON YOURSELF AND ON YOUR CLASSES. SEND IN RESULTS TO SCIENCE QUESTIONS, SCHOOL SCIENCE AND MATHEMATICS. *HOW LONG DID IT TAKE YOU TO ANSWER? HOW LONG FOR YOUR CLASS?*

PHYSICS I (First semester)

DIRECTIONS: The first column contains 15 terms. The second column contains phrases or clauses which are either definitions of the terms or some other means of identifying them. Find for each term in the first column a definition in the second column and put the number of the definition in the blank space in front of the number in the first column.

____	1 Acceleration	1—The measure of the attraction of the earth for a body.
____	2 Archimedes' Principle	2—The pull of the earth on a mass of one gram.
____	3 Centrifugal force	3—The process of finding the resultant of two or more forces.
____	4 Composition of forces	4—The process of carrying heat by means of a moving fluid.
____	5 Conservation of energy	5—Pressure applied to an enclosed fluid is transmitted equally and undiminished in all directions.
____	6 Dyne	6—The measure of the inertia of a body.
____	7 Energy	7—The number of B.T.U.s to raise the temperature of one pound of a substance one degree Fahrenheit.
____	8 Erg	8—The force which imparts to a gram mass an acceleration equal to 1 cm per second per second.
____	9 Gram of force	9—With every action (or force) there is an equal and opposite reaction.

3	10 Convection	10—The loss of weight of a body submerged in a liquid is equal to the weight of the liquid displaced.
____	11 Mass	11—The capacity for doing work.
1	12 Specific heat	12—The change in speed per unit of time.
____	13 Newton's 3rd Law of Motion	13—The work done when a force of 1 dyne moves though a distance of 1 cm.
5	14 Pascal's Law	14—Energy can neither be created nor destroyed.
1	15 Weight of a body	15—When anything is made to follow a curved path, the tendency to fly out from the center along a straight line.
		16—The force necessary to balance, or hold in equilibrium two forces.

BIOLOGY TEST

679. *Proposed by Samuel Strauss, GQRA No. 21. Garfield High School Akron, Ohio.*

Rear Admiral Richard E. Byrd, on his second Antarctic expedition, is now on his way to Little America near the South Pole. Since no plants and few animals live there, except whales and fish, he must take along sufficient food supplies to last a long time. All the members of the expedition are grown men. Every pound of supplies must go as far as possible. What kinds of food shall be taken on the expedition? Mark (X) the correct answers and correct reasons of those given below:

1. He should take equal quantities of all goods ( )
2. He should take fruits and vegetables. ( )
3. He should take a great deal of protein foods. ( )
4. He should take along much meat and fish. ( )
5. He should take many fat foods. ( )
6. He should take cod liver oil. ( )
7. He should take many carbonated beverages. ( )
8. He should take many concentrated sweets, such as candy, chocolate, and raisins. ( )
9. Most of the vegetables he takes would be in cans, or dried. ( )
10. He would take different kinds of nuts. ( )

Reasons:

1. Proteins are the most expensive class of foods. ( )
2. Fats give off $2\frac{1}{4}$ times as much heat as carbohydrates. ( )
3. All living things need food that regulates body processes. ( )
4. Vitamins are the most important class of foods. ( )
5. A good balanced meal consists of meat, whole baked potato, green beans, lettuce and tomato salad, whole wheat bread and butter, milk, and baked apple. ( )
6. People should eat one kind of food until they get tired of it, then switch to another. ( )
7. Not all people should eat the same kind and quantity of foods; the diet must be adjusted to age, work, health of the individual. ( )
8. People must have foods that prevent scurvy and rickets. ( )
9. A good balanced meal consists of meat, mashed potatoes, white bread and butter, pie and coffee. ( )

10. Certain essential foods are absolutely necessary for every living thing. ( )

Try out the above on yourself and on your classes. Send in results and times to answer to Science Questions, School Science and Mathematics

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BOOKS RECEIVED

Solid Geometry, by Frank M. Morgan, Director of Clark School (College Preparatory), Hanover, New Hampshire; formerly Assistant Professor of Mathematics, Dartmouth College, Hanover, New Hampshire; and W. E. Breckenridge, Head of the Department of Mathematics, Stuyvesant High School, New York City. Cloth. Pages vi+722+vii. 12.5×18.5 cm. 1934. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $1.24.

Foundations of Physics, by Alfred M. Butler, Head of Science Department, High School of Practical Arts, Boston. Cloth. Pages vii+613. 12.5×19 cm. 1934. M. Barrows and Company, Boston, Mass. Price $2.00.

The Physical Basis of Things, by John A. Eldridge, Professor of Physics, University of Iowa. First Edition. Cloth. Pages xiv+407. 14.5×23 cm. 1934. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York. Price $3.75.

The Arithmetic of Business, by Frank J. McMackin, Principal of William L. Dickinson High School, Jersey City; John A. Marsh, Head of Mathematics Department, High School of Commerce, Boston; and Charles E. Baten, Instructor in the Commercial Department, The Lewis and Clark High School, Spokane. Cloth. Pages ix+486. 13.5×20.5 cm. 1934. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.48.

The Poetry of Mathematics and Other Essays, by David Eugene Smith, Professor Emeritus of Mathematics, Teachers College, Columbia University. Cloth. Pages v+91. 13×19 cm. 1934. Scripta Mathematica, Yeshiva College, Amsterdam Avenue and 186th Street, New York. Price 50 cents paper cover and 75 cents cloth.

The Collared Lizard, A Laboratory Guide by D. Dwight Davis, Assistant, Department of Zoology, Field Museum of Natural History, Chicago, Ill. Cloth. Pages viii+57. 12.5×19 cm. 1934. The Macmillan Company, 60 Fifth Avenue, New York. Price 90 cents.

Silver Jubilee Commemoration Volume. Journal Vol. XX. Cloth. Pages x+248. 16×24.5 cm. 1933. S. Mahadeva Iyer, Presidency College, Madras, India.

Robert's School, by Stella Yowell, Professor of Education and English, State Teachers College, Mansfield, Pa. Cloth. 124 pages. 13×18.5 cm. 1934. Wheeler Publishing Company, 2831 South Park Way, Chicago, Ill. Price 60 cents.

Mastery Arithmetic, by George R. Bodley, Charles S. Gibson, Ina M. Hayes, and Bruce M. Watson. Cloth. 12.5×19 cm. 1934. Book One, pages vii+335. Price 72 cents. Book Two, pages ix+390. Price 76 cents. D. C. Heath and Company, 285 Columbus Ave., Boston, Mass.

The Diffraction of Light, X-Rays and Material Particles, by Charles F. Meyer, Associate Professor of Physics, University of Michigan. Cloth. Pages xiv+473. 16.5×24 cm. 1934. The University of Chicago Press, 5750 Ellis Ave., Chicago, Ill. Price $5.00.

Units in Chemistry, by Russell S. Howard, Head of the Science Department, Lyons Township High School and Junior College, La Grange, Ill. Cloth. Pages viii+756+lxviii. 13.5×19.5 cm. 1934. Henry Holt and Company, One Park Ave., New York.

Theoretical Physics, by Georg Joos, Professor of Physics at the University of Jena and Translated from the First German Edition by Ira M. Freeman, Ph.D., Chicago, Sometime Fellow of the Institute of International Education and the Von Humbolt Foundation at Frankfurt am Main. Cloth. Pages xxiii+748. 14.5×22 cm. 1934. Messrs. Blackie and Son, Limited, 50 Old Bailey, London, E.C. 4. Price 25s. net.

Review of Pre-College Mathematics, by C. J. Lapp, Professor of Physics, F. B. Knight, Professor of Educational Psychology, and H. L. Rietz, Professor of Mathematics, all at the University of Iowa. Paper. 124 pages. 21×27 cm. 1934. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Ill.

Outline of the History of Mathematics, by Raymond Clare Archibald, Professor of Mathematics, Brown University. Second Edition Revised and Enlarged. Paper. 58 pages. 15×23 cm. 1934. Mathematical Association of America, Inc., Oberlin, Ohio. Price 50 cents for a single copy; 10 or more copies 40 cents each.

Sound, by Harvey B. Lemon and Hermann I. Schlesinger, The University of Chicago. Paper. Pages iv+38. 13.5×20 cm. 1934. The University of Chicago Press, Chicago, Ill. Price 35 cents.

Geologic History at a Glance, compiled by L. W. Richards and G. L. Richards, Jr. Consists of two charts with photographs, diagrams and descriptions. One page of explanations and one page of selected references. Stanford University Press, Stanford University, Stanford, California.

The Status of Teachers of Secondary Mathematics in the United States by Ben A. Sueltz, Ph.D., Member of the American Committee of the International Commission on the Teaching of Mathematics. Paper. 151 pages. 14.5×23 cm. 1934. B. A. Sueltz, Cortland, New York. Price paper cover $1.25 and cloth cover $1.50.

BOOK REVIEWS

The Discovery of the Elements, collected reprints of a series of articles published in the Journal of Chemical Education, by Mary Elvira Weeks, Assistant Professor of Chemistry at the University of Kansas. Illustrations collected by F. B. Dains, Professor of Chemistry at the University of Kansas. Second Edition, Revised. 1934. pp. 363. 1.75×16.5×23.5 cm. Cloth. $3.00. Mack Printing Co.

A most interesting and valuable addition to any scientific library and more particularly to any High School Chemistry Departmental Library. Full of carefully gathered biography and history as well as the factual material regarding the discovery of the elements.

Many extremely interesting illustrations are provided. Another interesting feature is the chronology in the Appendix. A full list of the literature cited is also given, and there is a supplementary chapter on "Recently Discovered Elements."

FRANK B. WADE

A Textbook of Organic Chemistry, by Joseph Scudder Chamberlain, Ph.D. Professor of Organic Chemistry, Massachusetts State College; Author, Organic Agricultural Chemistry, Editor, Chemistry in Agriculture. Third Edition, Revised. Pp. xxv+873. 5.5×16.5×21.5 cm. Not illustrated but with tables and, of course many graphic formulae. Special water resisting cloth binding. 1934. $4.00. P. Blakiston's Son & Co.

This revision of an excellent textbook of organic chemistry may well be styled a typical American affair for it is certainly a "bigger and better" book than its predecessors. Nevertheless the author has condensed the material, which would be regarded as essential to a college course, by about 200 pages. This has been done by relegating to a new "Part III" many supplementary topics. The college teacher will thus find the regular assignments are all in Parts I and II. He can then make such special assignments as he chooses in Part III.

Some modernization of subject matter has been attempted especially concerning agreement with modern electronic theory and with reference to recent research on carbohydrates.

FRANK B. WADE

The Endless Quest, Three Thousand Years of Science, by F. W. Westaway, Author of "Scientific Method; its Philosophic Basis and its Modes of Application"; "Science and Theology: Some Common Aims and Methods" etc. Cloth. Pages xix+1080. 14.5×22 cm. 1934. Blackie and Son Limited, 50 Old Bailey, London, Price 21s. net.

This book is truly a marvel and its author a genius in the art of writing popular science. Every branch of both physical and biological science is examined and the story of the development of each is told in language as simple as can be used. But the book is more than a mere history of science. Every major development is critically examined and the work of each contributor impartially appraised. On controversial topics the facts and theories are presented so that the reader may form his own opinion. The British scientists are pointed out in particular but their works are not over-rated.

Atomic theory, radiation, archaeology, evolution, spectroscopy, meteorology, quantum theory, embryology, relativity are only a few of the subjects covered, and on each the author writes with the assurance of a master of the subject. From the earliest Greek philosophers to the last of the Nobel prize winners the great scientists of all countries pass in review. Extensive references are given at the close of each chapter. A reading of the book shows that these references are not appended merely for display. Extensive reading has made the book possible. It is almost a science library in itself.

G. W. W.

Foundations of Physics, by Alfred M. Butler, Head of the Science Department of the High School of Practical Arts, Boston. Cloth. Pages iv+613. 12.5×18.5 cm. 1934. M. Barrows & Company, Boston. Price $2.00.

If the high school student is to benefit any by the study of a science such as Physics it is above all necessary that the methods employed by

this science are clearly understood. The methods of approach and analysis constitute the tools which a student should acquire to aid him in understanding and solving the problems of daily life. The author of *Foundations of Physics* writes with the assumption that facts are tools. He proceeds from the more practical to the more abstract; drawing upon everyday experience wherever possible and introducing each principle by an application. This is an excellent method of approach. However, in proceeding from application to law, analysis is almost completely missing or very weak.

The author departs from the standard sequence of Mechanics first by starting with a discussion on Heat. It is impossible, however, if your object is to lay the "foundation" of Physics which is the concept of energy to start with heat. Mechanics begins with chapter eight. In the preface the author claims that this can be used as chapter one. In that case no "foundation" is laid for the discussion of mechanics. On the very second page the student is informed that weight is a pressure.

The author devotes 75 pages to a discussion of radio which is quite complete in facts. Such practical topics dealing with house heating, house ventilating, house wiring and household appliances receive a very prominent place.

Had the title of the text been "Physics and Everyday Applications" the book would certainly find its way as a text into trade schools and schools of practical arts.

C. Radius

Exercises in First Year Algebra, by George K. Sanborn, Instructor at Phillips Academy, Andover, Mass. Cloth. 148 pages. 12.5×18.5 cm. 1934. American Book Company, Chicago, Illinois.

This book is a convenient collection of supplementary material that covers the course in first year algebra. The exercises are graded as to difficulty. Each section is introduced by a large number of oral exercises which prepare the pupil for the written work that follows. The verbal problems are classified under the various types. The successive types are of increasing difficulty and are followed by two long lists of miscellaneous problems, the first involving linear equations and the second, quadratic equations. The book should be welcomed by teachers who are in need of supplementary material of this type.

G. E. Hawkins

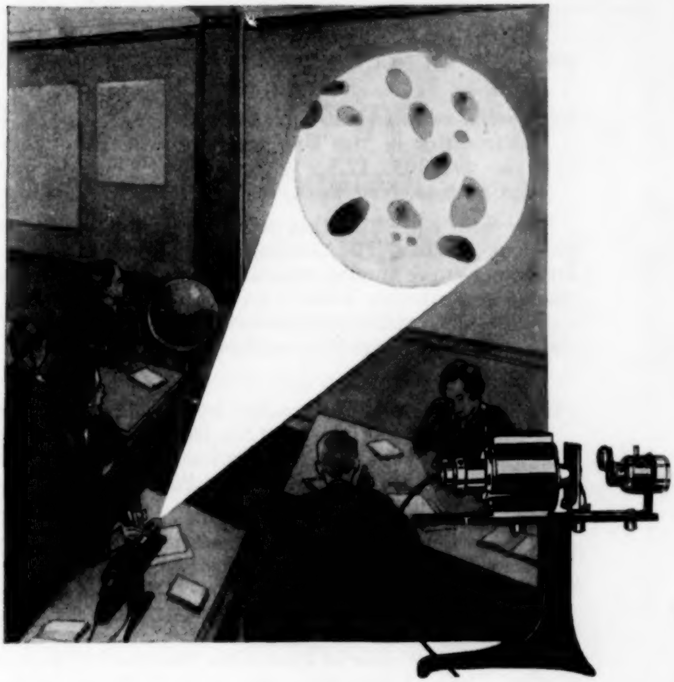
Tables of the Higher Mathematical Functions, Vol. I, by Harold T. Davis, Indiana University. Pages xiii+377. 18.5×25.5 cm. Cloth. Principia Press, Bloomington, Indiana. 1933. Price $6.50.

In this first volume Professor Davis and his staff have begun the ambitious program of bringing together a fairly complete set of tables of the higher mathematical functions.

The first half of the volume is divided into five parts as follows: Part I. The Classification and History of Tables; Part II. Modern Mathematical Instruments of Calculation; Part III. Interpolation and its Uses; Part IV. Interpolation Tables; Part V. Bibliography.

The second half of the volume gives six tables relating to the Gamma Function and six tables relating to the Psi Function. Since these tables are given to not less than ten decimal places (some of them run as high as twenty) and since all have been checked for errors, the magnitude of the contemplated work becomes apparent.

J. M. Kinney



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OPTICAL INSTRUMENTS FOR THE SCIENCES

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Differential and Integral Calculus, by Clyde E. Love, Ph.D. Professor of Mathematics in the University of Michigan. Third edition. Cloth. Pages xv+383. 12.5×19 cm. 1934. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.75.

The third edition of this popular text follows the general plan of the previous editions. The postponement of the chapters on indeterminate forms and curve tracing makes possible a corresponding advancement of the integral calculus. There is an increase in the number and variety of the exercises. The explanatory material has been extended in some places and the number of illustrative problems has been increased.

J. M. Kinney

Plane and Spherical Trigonometry, by Claude Irwin Palmer, Late Professor of Mathematics and Dean of Students, Armour Institute of Technology, and Charles Wilbur Leigh, Professor of Analytic Mechanics, Armour Institute of Technology. Cloth. Pages xiv+229. 16×23.5 cm. 1934. McGraw-Hill Book Company, New York, N. Y. Price $1.50.

This is the fourth edition of this well known text. The textual material has been retained. The problems have been changed.

J. M. Kinney

Mathematical Essentials for Elementary Statistics, by Helen M. Walker, Assistant Professor of Education, Teachers College, Columbia University. Cloth. Pages xiii+246. 12.5×18.5 cm. 1934. Henry Holt and Company, One Park Avenue, New York, N. Y. Price $1.50.

This book is written for the adult who, having forgotten his elementary mathematics, wishes to review it for the purpose of pursuing a course in statistics. The book contains those topics which contribute most directly to elementary statistical method. It presupposes very little knowledge of mathematics. It is algebraic in character but differs from the ordinary in that the symbolism is that which is characteristic of statistical mathematics. It stresses summation; develops such concepts as variable, parameter, and least squares; discusses homogeneity among moments; and derives a number of statistical formulas.

Almost every chapter begins with a self exploratory test. If a student can make a perfect score on this test, he may assume that he has sufficient understanding of the unit.

The book is written in a clear and interesting style.

J. M. Kinney

Essentials of Plane Trigonometry and Analytic Geometry, by Atherton H. Sprague, Associate Professor of Mathematics, Amherst College. Cloth. Pages x+228. 16×23.5 cm. 1934. Prentice-Hall, Inc. New York, N. Y. Price $1.80.

This book presents in a single volume the essentials of trigonometry and analytic geometry. The first chapter deals with logarithms. In the second chapter the trigonometric functions are defined in the restricted sense, and used in the third chapter to solve the right triangle. We find a good table of squares and square roots which is used to solve the oblique cases in which the law of cosines may be used. Chapters VIII to XV inclusive present the essentials of analytic geometry.

The book presents an attractive appearance. It will no doubt appeal to those schools which adhere to the standard courses in preparing students for the calculus.

J. M. Kinney

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New Biology, by W. M. Smallwood, Syracuse University; Ida L. Reveley, Wells College; and Guy A. Bailey, Genesoe State Normal School. Cloth. Pages viii+604. 1934. Allyn and Bacon, Boston, Mass.

This text is organized on the three unit basis—zoology, physiology, and botany. Since zoology is treated first it offers an appeal to the student in the fall months when he is surrounded by animal life especially insect life. Therefore it fits a *seasonal requirement*. Also since trees and plants in general are still abundantly in blossom, fruiting and seeding, it offers an adaptation to this requirement by providing the botany section as a unit. Life processes may be studied in plant life first if so desired, and still be in season. The botany section itself could be organized in a more logical manner if seeds were taken up at the beginning, with the natural order of life history of the plant studied in order of development. The plant probably provides a better basis for study of life processes from an experimental standpoint than does the animal, but this text allows the teacher to direct and adapt the course to the needs of the students. The physiology section occupying a central position between the other two units can be studied in the winter time when nature is dormant.

The natural appeal to the student of young high school age is also fulfilled in this text. The language is comparatively elementary with not many technical terms, hence the average student can readily understand it.

The pictures, diagrams, and notes are an improvement over the old edition in some cases. The sections on field problems, summary, references, and questions at the end of each chapter are well done and the bibliography, glossary, and index at the back of the book make it a valuable aid in teaching and learning. The appendix is well designed to check up formal classification and logical organization of subject matter. The unit tests and general tests make the book useful in a testing program. All these provide ample supplementary material. For these reasons the book is adapted to meet the needs of an enriched program in a larger high school where reference books and laboratory materials are available as well as in a small town, or township high school where nature itself is the only supplementary material available. The laboratory sections however are inadequate and need supplementing for a full laboratory course, but they and the field study may be used to direct this nature investigation, hence the student in a small high school has his course complete in a compact form.

The section devoted to vocations, and applied biology offers guidance in development of vocations and hobbies which are a present day demand in a high school course. A manual is provided for the inexperienced teacher to use. This manual has tests answered, and suggestions given.

Rose A. Phillips

NEW KIND OF HELIUM DISCOVERED

The production of a new kind of helium of atomic weight six instead of the usual four was reported to the International Conference on Physics by Prof. M. L. Oliphant of Cambridge's Cavendish Laboratory. Dr. Oliphant was one of the discoverers recently of triple-weight hydrogen. The new helium of atomic mass six was obtained by bombarding beryllium with deutons, the hearts of double-weight hydrogen.

Helium is the rare gas of the air first discovered in the sun. Nearly a half century later it was found in the air of the earth. During the World War, American chemists extracted it from natural gas in quantity and used it to fill airships, replacing inflammable hydrogen gas.

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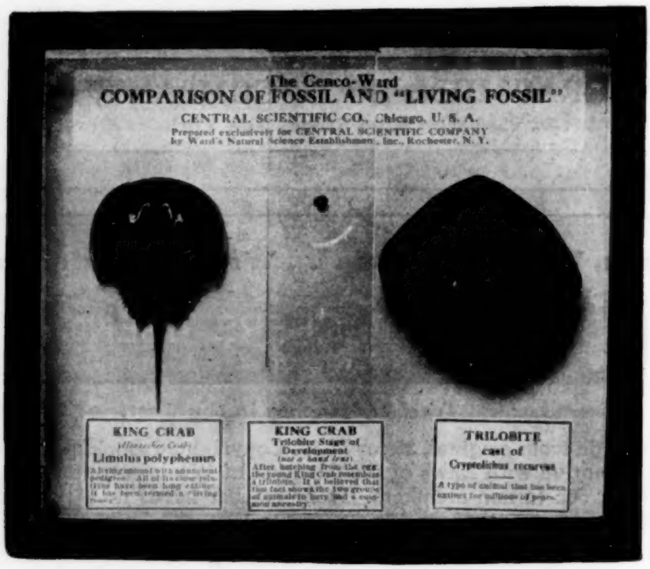

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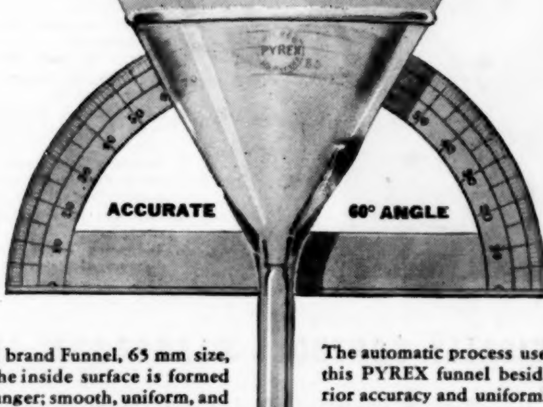

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